ECSI No. 84
September 11, 2019
Gasco Sediments Cleanup Action

Revised Pre-Remedial Design Data Gaps Work Plan

Prepared for U.S. Environmental Protection Agency, Region 10

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Prepared for
U.S. Environmental Protection Agency
Region 10
1200 Sixth Avenue
Seattle, Washington 98101

Prepared by
Anchor QEA, LLC
6720 SW Macadam Avenue
Suite 125
Portland, Oregon 97219

On Behalf of
NW Natural
220 NW 2nd Avenue
Portland, Oregon 97209

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ABBREVIATIONS

AOC	*Administrative Settlement Agreement and Order on Consent*
CFR	Code of Federal Regulations
CMC	Criterion Maximum Concentration
COC	contaminant of concern
COP	City of Portland Datum
CPT	cone penetration test
CRD	Columbia River Datum
DCE	1,2-dichloroethene
DDx	dichlorodiphenyltrichloroethane, dichlorodiphenyldichloroethylene, and dichlorodiphenyldichloroethane
DEQ	Oregon Department of Environmental Quality
DMU	dredge management unit
DNAPL	dense nonaqueous phase liquid
DOC	depth of contamination
Draft EE/CA	*Draft Engineering Evaluation/Cost Estimate*
DSL	Oregon Department of State Lands
EPA	U.S. Environmental Protection Agency
ESB	Equilibrium Partitioning Sediment Benchmarks
FFP	full-flow penetration
FMD	future maintenance dredge
FS	Feasibility Study
LiDAR	light detection and ranging
LOE	line of evidence
MGP	manufactured gas plant
NAPL	nonaqueous phase liquid
NRC	not reliably contained
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
ppb	part per billion
Pre-RD	Pre-Remedial Design Investigation
PTW	principal threat waste
PTW-highly toxic	surface sediments containing concentrations exceeding the "highly toxic" concentrations identified in ROD Table 21
PTW-NAPL	source material containing visual mobile nonaqueous phase liquid
RAL	remedial action level
RBC	risk-based concentration

RCRA	Resource Conservation and Recovery Act
ROD	*Record of Decision – Portland Harbor Superfund Site, Portland, Oregon*
Siltronic	Siltronic Corporation
SMA	sediment management area
SOW	*Statement of Work – Gasco Sediments Site*
SPT	standard penetration test
TCE	trichloroethylene
TCLP	toxicity characteristic leaching potential
TEWP	*Final Pre-Remedial Basis of Design Technical Evaluations Work Plan*
TOC	total organic carbon
TPAH	total polycyclic aromatic hydrocarbon
TPH	total petroleum hydrocarbon
USACE	U.S. Army Corps of Engineers
VOC	volatile organic compound
Work Plan	*Pre-Remedial Design Data Gaps Work Plan*

1 Introduction and Objectives

This *Revised Pre-Remedial Design Data Gaps Work Plan (*Work Plan*)* has been prepared by Anchor QEA, LLC, on behalf of NW Natural for the Gasco Sediments Site, located on the Willamette River adjacent to the NW Natural Gasco and Siltronic Corporation (Siltronic) properties in Portland, Oregon (Figure 1). This Work Plan has been prepared under the *Administrative Settlement Agreement and Order on Consent* (AOC; Docket No. CERCLA 10-2009-0255) and *Statement of Work – Gasco Sediments Site* (SOW; EPA 2009), as well as the Schedule of Deliverables approved by the U.S. Environmental Protection Agency (EPA) on June 19, 2017. This Work Plan summarizes the remaining data gaps identified in the *Final Pre-Remedial Basis of Design Technical Evaluations Work Plan* (TEWP; Anchor QEA 2019a) and the associated field sampling methodologies to fill those data gaps at the Gasco Sediments Site. The data gaps sampling is being implemented to collect additional site-specific data within the EPA-identified Gasco Project Area shown in Figure 2 and Gasco Sediments Site shown in Figure 1. These data will be used to refine the Gasco Sediments Site active cleanup boundaries (herein termed the Interim Project Area to maintain consistency with the terminology used in the SOW) identified in the *Draft Engineering Evaluation/Cost Estimate* (Draft EE/CA; Anchor QEA 2012a) and subsequently refined in the *Record of Decision – Portland Harbor Superfund Site, Portland, Oregon* (ROD; EPA 2017) via sediment management areas (SMAs), as well as to support completion of the technical evaluations presented in the TEWP.

An initial version of this Work Plan was submitted to EPA on June 10, 2019. Following that submittal, NW Natural and EPA worked collaboratively to respond to questions and comments raised on the Work Plan, which are incorporated in this Work Plan. Specifically, this Work Plan includes the following documents as appendices in chronological order:

- Appendix G – A summary of the site-specific cap modeling and long-term monitoring approach at the Gasco Sediments Site dated June 25, 2019, developed collaboratively with EPA.
- Appendix H – The PowerPoint presentation *Updated Pre-RD Data Gaps Sampling Technical Briefing – Gasco Sediments Site* dated June 26, 2019, that summarizes the proposed pre-remedial design investigation data gaps sampling approach at the Gasco Sediments Site.
- Appendix I – An addendum to the initial version of the Work Plan that was submitted to EPA on July 3, 2019. The addendum re-inserted sampling in the upriver portion of the Interim Project Area that was removed due to a misunderstanding based on EPA's March 2019 Project Area map, and it proposed the collection of a single core outside the perimeter of the Interim Project Area to evaluate subsurface sediments containing ROD Table 21 remedial action level (RAL) and principal threat waste (PTW)-highly toxic threshold exceedances without surface sediment exceedances (i.e., buried contamination). The additional scope of work activities proposed in the addendum are incorporated into the text, tables, and figures of this Work Plan.

- Appendix J – The PowerPoint presentation *Summary of Core Processing Procedures – Gasco Sediments Site* dated July 22, 2019, that summarizes the various subsurface sediment coring activities proposed in the initial version of the Work Plan. This presentation was provided to EPA and the Technical Coordination Team on August 1, 2019, to summarize the number and location of cores proposed to facilitate completion of eight different remedial design evaluations presented in the initial version of the Work Plan, and the associated sampling intervals and chemical analyte list.
- Appendix K – Responses to EPA comments on the June 10, 2019 version of the Work Plan and EPA's September 6, 2019 conditional approval letter of the Work Plan, TEWP, and cap modeling and long-term performance monitoring approach. Any revisions required by the comments and conditional approval letter are incorporated in this Work Plan.

1.1 Work Plan Purpose and Objectives

The purpose of this Work Plan is to present the rationale for additional sample collection and associated sampling methodologies to address the data gaps identified in the TEWP necessary to complete the final remedial design for the Gasco Sediments Site. This Work Plan presents the data gaps identified in the TEWP in two categories: those that do not and those that do require field sampling and analysis. Table 1 summarizes each technical evaluation section in the TEWP that identifies a data gap, whether field sampling and analysis (versus the use of existing information) is required to fill the data gap, and the proposed sampling media for each data gap that requires field sampling and analysis. Please note that the initial draft TEWP identified the anticipated performance of diver push probe surveys along the portion of the Siltronic and Gasco property riverbank that contains heavy riprap to determine the lateral extent of riprap that extends into the Interim Project Area. NW Natural has replaced the use of divers with a comprehensive, integrated multibeam echo sounder and light detection and ranging (LiDAR; see Section 2.5) survey to obtain better aerial survey coverage in the Interim Project Area and to minimize safety concerns associated with the use of divers. This change was approved by EPA, and the survey was completed in April 2019 in accordance with the EPA-approved *Hydrographic and Topographic Survey Work Plan* (Anchor QEA 2019b).

The data gaps sampling activities are currently estimated to occur between September through November contingent on meeting the current EPA approval timeline for this Work Plan. The individual sampling activities will be sequenced based on subcontractor availability and the most efficient means to achieve the sampling objectives.

1.2 Document Organization

The remainder of this document is organized into the following sections:

- Section 2 – Data Gaps Identified Requiring No Sampling and Analysis
- Section 3 – Data Gaps Sampling and Analysis

- Section 4 – Reporting
- Section 5 – References

The following appendices are attached to this document:

- Appendix A – *Pre-Remedial Design Data Gaps Field Sampling Plan*
- Appendix B – *Pre-Remedial Design Data Gaps Quality Assurance Project Plan*
- Appendix C – *Pre-Remedial Design Data Gaps Health and Safety Plan*
- Appendix D – Memorandum Regarding: "NW Natural Response to EPA Comments on NW Natural's Pre-RD Data Gaps Sampling Technical Briefing – Gasco Sediments Site"
- Appendix E – Supporting Information for Buried Contamination Evaluation Along Perimeter of Project Area
- Appendix F – Supporting Figures for Paired Subsurface Sediment and Porewater Biogas Generation Potential Locations
- Appendix G – Memorandum Regarding: "Summary of Final Cap Modeling and Long-Term Cap Monitoring Approach – Gasco Sediments Site"
- Appendix H – *Updated Pre-RD Data Gaps Sampling Technical Briefing – Gasco Sediments Site*
- Appendix I – Memorandum Regarding: "Addendum to the Pre-Remedial Design Data Gaps Work Plan – Gasco Sediments Site"
- Appendix J – *Summary of Core Processing Procedures – Gasco Sediments Site*
- Appendix K – Memoranda Regarding: "NW Natural Response to EPA Comments on Work Plan" and "NW Natural Response to EPA Conditional Approval Letter on the Gasco Sediments Site TEWP, DGWP, and Capping Approach"

2 Data Gaps Requiring No Sampling and Analysis

Several data gaps were identified in the TEWP that do not require sampling and analysis. These data gaps are discussed in more detail in the following subsections and are organized consistent with the technical evaluations presented in the TEWP.

2.1 Capping Demonstration Evaluation

The following elements of the capping demonstration evaluations described in Section 4.1 of the TEWP require no additional sampling and analysis during the data gaps investigations. The data gaps will be addressed using existing publicly available information.[1]

2.1.1 Element 2 – Flood Flow Impacts

Data gaps associated with flood flow impacts from cap placement and other remedial technologies are discussed in Section 2.4.

2.1.2 Element 3 – Erosion Resistance

As described in Section 4.1.5.2 of the TEWP, the information required to evaluate and design the erosion protection layer for the sediment cap will be gathered from available sources from previous analyses performed as part of the *Portland Harbor RI/FS – Draft Feasibility Study* (Anchor QEA 2012b), described as follows:

- **River Currents:** To evaluate the potential effects of river currents during design flood conditions on a sediment cap, simulations of the flood events will be performed using the calibrated high-resolution two-dimensional Environmental Fluid Dynamics Code hydrodynamic model of the Lower Willamette River. This model was originally developed in support of the *Portland Harbor RI/FS – Draft Feasibility Study* (Anchor QEA 2012b) prepared by the Lower Willamette Group. Specific details of this model, model development, and boundary conditions are discussed in Appendix C of the EPA FS (EPA 2016). The model was updated and refined as part of the Gasco Sediments Site Draft EE/CA (Anchor QEA 2012a), as discussed in Appendix E of the Draft EE/CA. The model will provide depth-averaged velocities and water depths over the cap during a range of flood conditions. The model in the vicinity of the Gasco Sediments Site will be updated, if necessary, based on the integrated multibeam bathymetry and LiDAR survey performed by NW Natural at the Gasco Sediments Site in April 2019 in accordance with the EPA-approved *Hydrographic and Topographic Survey Work Plan* (Anchor QEA 2019b) and collected throughout the Portland Harbor Superfund Site by the Pre-Remedial Design Investigation (Pre-RD) AOC Group in March and April 2018 (AECOM 2018a, 2018b). The model grid will be refined, if needed, to capture key

[1] Certain proprietary (or at least not publicly available) information may be needed when considering treatment requirements.

morphological features identified in the bathymetry. Simulations will be performed with the model for a full range of return-interval flow conditions (up to and including the 500-year return-interval flow event) to evaluate the sensitivity of the changing return-interval flow rates in response to long-term changes in flow as a result of changing climate patterns.

- **Wind-Generated Waves:** Wind data measured at the Portland International Airport will be obtained from the National Climatic Data Center and the Meteorological Resource Center. Fetch measurements to the Gasco Sediments Site and average water depths along each fetch will be computed based on the existing bathymetry data for the Willamette River and Gasco Sediments Site (DEA 2018; Anchor QEA 2019b) (additional site-specific bathymetry and topography are discussed in Section 2.5). These data will be used to compute wind-generated wave heights at the Gasco Sediments Site for a range of wind conditions using the same methodology as described in Appendix Hc of the *Portland Harbor RI/FS – Draft Feasibility Study* (Anchor QEA 2012b).
- **Vessel Traffic Information:** Appendix Hc of the *Portland Harbor RI/FS – Draft Feasibility Study* (Anchor QEA 2012b) describes the vessel types and ship traffic patterns in the Lower Willamette River. This information will be updated based on a review of the following:
  - The U.S. Army Corps of Engineers' (USACE's) database on annual trips and drafts of vessels on the Lower Willamette River
  - USACE's database on vessels residing in the Port of Portland
  - Port of Portland documents on arrivals and departures of all industrial vessels
  - NW Natural information documenting lessee vessel traffic (vessel dimensions and operating speeds)

  Data obtained as part of this effort will be used to evaluate propeller wash and vessel-generated waves as follows:

  - **Propeller Wash:** Vessel traffic information and vessel characteristics (e.g., propeller type, draft, and engine horsepower) for commercial and recreational vessels, operating conditions (including the propeller orientation and percentage of applied horsepower), whether the vessel is not situated directly over the cap, and the horizontal distance between the vessel and the cap footprint will be used to support the propeller wash evaluation. The propeller wash analysis will be performed using the same methodology as described in Appendix Hc of the *Portland Harbor RI/FS – Draft Feasibility Study* (Anchor QEA 2012b).
  - **Vessel-Generated Waves:** Two separate analyses will be used to evaluate vessel-generated waves at the Final Project Area; the Bhowmik et al. (1991) methodology will be used for small recreational vessels, and the Weggel and Sorensen (1986) methodology will be used to evaluate large commercial vessels. A variety of representative recreational and commercial vessels that are known to operate or have

the potential to operate near the cap will be evaluated for vessel-generated waves. The vessel-generated wave analysis presented in the EPA FS (EPA 2016) included pushboats, passenger ferries, fireboats, and jetboats as representative vessels and concluded that a passenger ferry should be used as the design vessel for the Final Project Area (Anchor QEA 2012b). However, multiple recreational and commercial vessels will be assessed during the remedial design evaluation to determine which vessel(s) may realistically constitute a "worst-case" scenario based on water depth and proximity to shore.

2.1.3 Element 4 – Presence and Effect of Debris

As described in Section 4.1.6.2 of the TEWP, the likely extent of debris will be determined through review of the existing detailed 2011 and 2018 bathymetry, the 2011 side scan sonar survey, drawings, photos, and other historical information. This review process will include evaluation of the following information, where available:

- Debris material type (e.g., wood, brick, concrete, rock, metal, or vegetation)
- Debris size (e.g., length, width, and height above mudline) and orientation
- Debris embedment depth
- Debris relative shape and characteristics (e.g., solid or open structure)
- Mapping of abandoned pilings extending above the mudline and general condition (i.e., degree of weathering)
- Debris type and extent encountered during the 2005 Gasco Early Action construction

In addition, observations during previous work at the Gasco Sediments Site will be considered when evaluating the following elements:

- Nature and extent of any debris observed during low water conditions monthly inspections of the pilot cap placed during the 2005 Gasco Early Action
- Debris that was encountered previously during sampling and analysis at the Interim Project Area

2.1.4 Element 7 – Treatment Requirements

As described in Section 4.1.9 of the TEWP, treatment (e.g., amendment with activated carbon or organoclay) requirements are not specifically addressed in capping guidance documents but are considered as part of the contaminant confinement assessment that will be completed during remedial design. If the nine other capping elements are met during remedial design and contaminant isolation modeling shows that treatment is required, the chemical isolation model (Section 3.2.1) will be revised to explicitly represent the sorption characteristics of active media in its calculations of transport and attenuation within the cap. The chemical isolation model will be used to optimize the cap configuration (i.e., thickness and amendment composition). Data collected as part of Capping Demonstration Evaluation Element 1 – Contaminant Confinement (Sections 3.2.1 and 3.2.2) will be used to support treatment requirement evaluations. Physical (e.g., bulk density) and sorption properties (e.g., linear partition coefficients or Freundlich isotherms) of the amendments being considered will be derived from vendor material specifications and data from literature describing the sorptive characteristics for input to the chemical isolation model.

2.1.5 Element 10 – Oregon Department of State Lands Authorization Requirements

The Oregon Department of State Lands (DSL) owns submerged and submersible lands of the state's navigable waterway system and issues location- and action-specific authorizations for conducting remedial activities, as well as implementing long-term monitoring or maintenance activities on DSL-owned submerged aquatic lands (Oregon Administrative Rule 141-145). The Interim Project Area includes DSL-owned submerged lands below the ordinary high water mark, extending to the edge of the Willamette River Federal Navigation Channel. Remedial activities within the Final Project Area will require an easement or other authorization from DSL. The specific terms and conditions and appropriate duration of the authorization will be developed in consultation with DSL and influenced by the design and location of remedial activities, long-term maintenance requirements, and consideration of any institutional controls identified within the Final Project Area. The Basis of Design report will document the status or outcome of DSL consultations on authorization.

2.2 Functional Structures Determination

As discussed in Section 4.6 of the TEWP, functional structures determinations will be based on a review of each structure within the Final Project Area to determine whether the structure is permanent, functional, or needed and if so, whether a structure can remain in place without being impacted by the selected sediment remedy. The functional structural determinations will be performed using a combination of as-built drawings (or structural design documents where no as-built drawings are available), understanding of structural conditions (e.g., condition of the structure and anticipated estimated remaining life), existing and proposed geotechnical data (see Section 3.2.3), and current and future site uses. No structure-specific data gaps field sampling activities are required to support the functional structure determinations.

2.3 Water Quality Best Management Practice Evaluation

As described in Section 4.7 of the TEWP, existing empirical data for water quality operational and barrier control performance and implementability issues documented at other environmental dredging projects will be compiled and evaluated during remedial design. This data will include the water quality best management practices implemented during the NW Natural Gasco Site Removal Action (Anchor Environmental 2004). Geotechnical data will be collected as described in Section 3.2.3

to support design evaluations of possible water quality barrier control alignments and types of control.

2.4 Flooding Impact Evaluation

As described in Section 4.9 of the TEWP, the flooding impact evaluation will be performed via HEC-RAS modeling to confirm that the overall sediment remedy attains "no-rise" certification in accordance with Federal Emergency Management Agency Region X guidance (FEMA 2013). For the hydraulic analysis for the overall remedy, the existing bathymetry of the Final Project Area (i.e., areas of proposed capping, dredging, and other mudline alterations) and the design post-construction bathymetry will be used. The April 2019 merged topography and bathymetry survey identified in Section 2.5 will be used for this evaluation; therefore, no data gaps are identified to support completion of the flooding impact evaluation.

2.5 Bathymetry and Topography Survey

NW Natural performed an integrated multibeam bathymetry and LiDAR survey at the Gasco Sediments Site in April 2019 in accordance with the EPA-approved *Hydrographic and Topographic Survey Work Plan* (Anchor QEA 2019b). This survey provided comprehensive survey coverage of the riverbank, nearshore, and navigation channel. This survey also supports estimation of the offshore extent of riverbank riprap adjacent to the Siltronic and southern Gasco properties and determination of the location of debris and piles extending above the mudline. This information will support both the dredging and capping demonstration evaluations described in the TEWP.

The most recent upland topography surveys were performed in 2006 and 2011. The LiDAR data from 2014 was compared to the 2011 survey data and does not show any significant changes in topography. Aerial photographs were reviewed in Google Earth from 2011 to present, and no activities were observed in the vicinity of the riverbank that would indicate changes to topography. In addition, the April 2019 survey did not identify any significant nearshore changes in topography. Recent regrading work was completed, and low berms were added in the past year (late 2018 to early 2019) to support stormwater best management practices, but not to the extent they would cause significant changes as the constructed berms were typically less than 1 foot. As such, the topography in the direct vicinity of the riverbank has not changed substantially since these survey dates, so NW Natural does not propose an updated survey landside of the top of the riverbank.

3 Data Gaps Sampling and Analysis

Data gaps sampling will include collecting surface sediment grabs to support the Interim Project Area refinement evaluation and depositional sediment quality evaluation; performing geotechnical explorations to support the capping demonstration, dredging, and water quality best management practices evaluations; advancing angled sonic cores to support the riverbank remedy evaluation; and collecting subsurface sediment cores to support evaluation of elevated concentrations of buried contamination that may present a future source of contamination if exposed and the dredging and capping demonstration evaluations. These sampling activities will be performed in the ROD-identified SMA (which is herein renamed the Interim Project Area) contained within the EPA-identified Gasco Project Area shown in Figure 2 and Gasco Sediments Site shown in Figure 1. Data gaps sampling objectives and data collection approaches for these evaluations are discussed in the following subsections. Detailed sampling methodologies are discussed in the *Pre-Remedial Design Data Gaps Field Sampling Plan* (Appendix A), analytical methods and quality control are discussed in the *Pre-Remedial Design Data Gaps Quality Assurance Project Plan* (Appendix B), and the site-specific health and safety approach for Anchor QEA field personnel is discussed in the *Pre-Remedial Design Data Gaps Health and Safety Plan* (Appendix C). The data density for each data gaps sampling activity will account for the following existing datasets collected in the vicinity of the Interim Project Area under EPA-approved plans that were not included in the EPA ROD and FS dataset (EPA 2017):

- Surface sediment data collected by NW Natural and reported in the Year 0, 1, 2, and 3 long-term post-construction monitoring reports of the Early Action Area (Anchor Environmental 2007, 2008; Anchor QEA 2009, 2010a)
- Subsurface sediment and toxicity characteristic leaching procedure (TCLP) data collected by NW Natural and reported in the Draft EE/CA (Anchor QEA 2012a)
- Seepage meter data collected by NW Natural as part of the “Revised NW Natural Proposed Summer 2017 Interim Pre-Remedial Design Data Gaps Field Sampling – Gasco Sediments Site” memorandum (Anchor QEA 2017)
- Surface sediment data collected by NW Natural as part of the *Revised NW Natural Proposed Spring 2018 Interim Pre-Remedial Design Data Gaps Field Sampling – Gasco Sediments Site* (Anchor QEA 2018a)
- Surface and subsurface sediment data collected and reported by the Pre-RD AOC Group as part of the harbor-wide baseline monitoring (AECOM and Geosyntec 2019a, 2019b)

NW Natural proposes to perform the data gaps sampling and analysis as soon as practicable upon EPA approval of this Work Plan and its associated *Pre-Remedial Design Data Gaps Field Sampling Plan* (Appendix A), *Pre-Remedial Design Data Gaps Quality Assurance Project Plan* (Appendix B), and *Pre-Remedial Design Data Gaps Health and Safety Plan* (Appendix C). Sediment sampling conducted as part of EPA-approved plans under the framework of NW Natural’s AOC does not require obtaining other federal, state or local permits, so long as the work is conducted in substantive compliance with the requirements of those permits and regulations. EPA has indicated that the work can proceed with no additional permitting and that the work can occur outside the generally approved in-water work window of July 1 to October 31, provided that standard best management practices are implemented to avoid adverse effects to fish and wildlife and the aquatic environment (Sheldrake 2018).

A primary objective of the data gaps sampling activities is to collect the necessary data throughout the Project Area to evaluate application of the remedial technologies consistent with ROD Section 14 and Figure 28. The ROD allows flexibility for application of capping and dredging technologies with the following stated limitations:

- Navigation channel: ROD Section 14.2.1 states, "The Selected Remedy in the federally-authorized navigation channel includes dredging to avoid constructing a remedy (cap or residual layer) within the authorized dredge depth."
- Future maintenance dredge (FMD) areas: ROD Section 14.2.2 states, "Contaminated sediment will be dredged to the depth of the Site-wide RAL concentrations shown in Table 21 in Appendix II or to a depth required to allow placement of a cap or backfill sufficient to be effective over the long term."
- Intermediate region: ROD Section 14.2.3 states, "In the intermediate region, contaminated sediment will be dredged to the depth required to achieve RALs (see Table 21 in Appendix II) and remove PTW, or to a depth required to allow placement of cap or backfill material sufficient to be effective over the long term as described in the Section 14.2.9, Design Requirements."
- Shallow region: ROD Section 14.2.4 states, "Contaminated sediment in this area will be dredged to the depth required to remove all NAPL or PTW that cannot be reliably contained (see Table 21 in Appendix II), unless it is present below the feasible depth limit of excavation technology, in which case it will be capped as described in Section 14.2.9, Design Requirements, and as approved by EPA in accordance with the decision tree shown in Figure 28 in Appendix I. Where PTW is not present but the depth of excavation to achieve RAL concentrations is greater than 5 feet, the area will be dredged to 5 feet with placement of a cap and backfilled to grade (capped per design requirements in Section 14.2.9, Design Requirements)."
- All areas containing PTW-NAPL/NRC: Sections 14.2.1 through 14.2.4 state, "NAPL or PTW <u>that cannot be reliably contained</u> [emphasis added] will be dredged unless it is present below the feasible depth limit of excavation technology, in which case it will be capped as described in Section 14.2.9, Design Requirements, and as approved by EPA."

Consistent with this ROD remedial technology framework, this Work Plan proposes a sampling design that collects the data necessary to perform the capping demonstrations identified in Section 4.1 of the TEWP (Anchor QEA 2019a) and Section 3.2 of this Work Plan, and the dredging evaluations identified in Section 4.2 of the TEWP and Section 3.4 of this Work Plan, throughout the entire Project Area. The capping demonstration sampling design specifically accounts for the ROD-identified dredging requirements to the authorized maintenance dredging elevation (plus overdredge tolerances plus a buffer) in the navigation channel and Gasco FMD and to 5 feet below mudline in the Shallow Region containing no PTW-NAPL/NRC. This Work Plan limits the collection of data necessary to identify the depth of contamination (DOC) throughout the portion of the Project Area currently shown to contain PTW-NAPL. If the capping demonstration cores located in the upriver and downriver portions of the Project Area outside of the current PTW-NAPL boundary identify the presence of PTW-NAPL in the bottom depths of the core, the DOC will be identified in the core as discussed in Section 3.4 of this Work Plan. Regardless of the presence/absence of PTW-NAPL in these upriver and downriver portions of the Project Area, NW Natural acknowledges that dredging may be required in these areas based on remedial design evaluations so the data necessary to complete other facets of the dredging evaluation (see Section 3.5 of this Work Plan) are proposed in these areas. NW Natural will also archive samples in consecutive 1-foot intervals throughout the full core recovery depth in the portions of the Project Area currently containing no PTW-NAPL in case data from these intervals are necessary to support DOC determinations during remedial design.

Although this Work Plan has been developed to fill all the data gaps necessary to complete the technical evaluations described in the TEWP and this Work Plan, NW Natural acknowledges that additional pre-remedial design investigation activities may be necessary if data gaps remain following completion of the sampling activities in this Work Plan.

3.1 Interim Project Area Refinement Evaluation

Consistent with the ROD and Section 3 of the TEWP, NW Natural will refine as necessary the Interim Project Area initially identified in the Draft EE/CA (Anchor QEA 2012a) and refined in the ROD via the SMA footprints through the collection of additional surface and subsurface sediment data along the perimeter of the Interim Project Area. This section includes a summary of the data gaps sampling objectives, sampling design, and the data collection approach to satisfy the data gaps identified throughout Section 3 of the TEWP.

3.1.1 Interim Project Area Refinement Evaluation Data Gaps Sampling Objectives and Sampling Design

The data gaps sampling objective of the Interim Project Area refinement evaluation is to refine as necessary the ROD-identified Interim Project Area based on the collection of additional surface and subsurface sediment data along the perimeter of the boundary. Consistent with the ROD and

Section 3 of the TEWP, this refinement will be performed based on the presence of PTW, surface sediment exceedances of the ROD Table 21 RALs and PTW thresholds, subsurface sediment exceedances of the Table 21 RALs and PTW thresholds in areas with potential for future exposure based on chemical and physical characteristics, and data adequacy for remedial design considerations. A brief summary of each of these lines of evidence (LOEs) is provided as follows:

- **Presence of PTW.** The following ROD criteria will be utilized to identify PTW in the Interim Project Area: 1) source material containing visual mobile nonaqueous phase liquid (NAPL; herein termed "PTW-NAPL" to maintain consistency with the ROD terminology) in surface and subsurface sediments; 2) surface sediments containing concentrations exceeding the "highly toxic" thresholds identified in ROD Table 21 (herein termed "PTW-highly toxic"); and 3) subsurface sediments containing concentrations exceeding the ROD Table 21 PTW-highly toxic thresholds in areas with potential for future exposure based on the chemical and physical characteristics. Visual mobile NAPL will be identified in both surface sediment and subsurface sediment cores during sample logging using the following site-specific visual definition identified in Section 3.6.2.1. of the SOW: "Any layer or seam of product, regardless of thickness, that is clearly defined as liquid NAPL that is also mobile (i.e., 'oozes' or 'drips' out of the core during core observations)." As detailed in the Draft EE/CA (Anchor QEA 2012a) and depicted in the ROD, the PTW-NAPL boundary is defined by the outer perimeter of subsurface sampling locations that contain no PTW-NAPL throughout the complete sampled depth. The refined PTW boundary will encompass the outer boundary of each form of PTW following completion of the sampling identified in this Work Plan. Please note that, as discussed with EPA during the technical meeting on April 4, 2019, the FS-level PTW-NRC thresholds identified in ROD Tables 7 and 21 are based on conditions not present at the Gasco Sediments Site. NW Natural will develop for EPA's review and approval site-specific PTW-not reliably contained (NRC) thresholds, if any, in the *Pre-Remedial Basis of Design Report* via the capping demonstration evaluation described in Section 4.1 of the TEWP.
- **Portland Harbor ROD RALs.** Surface (i.e., 0 to 1 foot) sediment concentrations will be compared against the focused contaminants of concern (COCs) RALs presented in Table 21 of the ROD and exceedances will be interpolated using the natural neighbor contours approach EPA used in the ROD. Subsurface sediment concentrations will also be compared against the focused COC RALs presented in Table 21 of the ROD to determine if any exceedances have the potential for future exposure based on the chemical and physical characteristics.
- **Additional Considerations.** Refinements to the Interim Project Area will also consider the age of the data (temporal relevance) and data density deemed sufficient for remedial design evaluations.

The rationale for the proposed surface and subsurface locations to refine the Interim Project Area based on application of the prior-listed LOEs is described in the following sections.

3.1.1.1 Surface Sediment Grabs

Consistent with the TEWP and EPA's Specific Comment 3 dated December 14, 2018, on NW Natural's November 27, 2018 *Pre-RD Data Gaps Sampling Technical Briefing – Gasco Sediments Site* (responses are included in Appendix D), NW Natural used the following LOEs to identify proposed surface (0 to 1 foot) sediment grab locations to refine the perimeter of the Interim Project Area:

1. Updated RAL focused COC and PTW-highly toxic threshold natural neighbor exceedance contours using the ROD surface sediment dataset supplemented with the additional surface sediment data identified in Section 3 that has been collected under EPA-approved plans
2. PTW-NAPL boundary identified in the ROD supplemented with the additional PTW-NAPL visual observations during the additional surface sediment sampling identified in Section 3 under EPA-approved plans
3. The age (temporal relevance) of closely located surface sediment grabs collected along the perimeter of the Interim Project Area boundary at different times
4. Data density along the perimeter of the Interim Project Area

3.1.1.1.1 Updated RAL Focused COC and PTW-Highly Toxic Threshold Natural Neighbor Exceedance Contours

The updated RAL focused COC and PTW-highly toxic threshold natural neighbor exceedance contours using the additional data identified in Section 3 are shown in Figure 3 relative to the Interim Project Area. These updated contours show no surface sediment threshold exceedances for PTW-highly toxic or total polycyclic aromatic hydrocarbon (TPAH); total polychlorinated biphenyl (PCB); total dichlorodiphenyltrichloroethane, dichlorodiphenyldichloroethylene, and dichlorodiphenyldichloroethane (DDx); or dioxin/furan RALs outside of the Interim Project Area in the navigation channel (which is primarily governed by the PTW-NAPL boundary). Therefore, no surface sediment grabs are proposed to refine the contours in this area.

The updated RAL focused COC and PTW-highly toxic threshold natural neighbor exceedance contours outside of the navigation channel within the Interim Project Area continue to cover from the navigation channel to the riverbank (Figure 3). Therefore, no surface grabs are proposed to refine the contours in this area.

3.1.1.1.2 PTW-NAPL Refinement

No surface sediment grabs are proposed to refine the Interim Project Area based on the presence of PTW-NAPL because this refinement will be based on the proposed sediment cores (see Section 3.1.1.2). However, visual observations for PTW-NAPL will be made for all surface sediment grabs, and the PTW-NAPL boundary will be adjusted as necessary.

3.1.1.1.3 Data Temporal Relevance

The temporal relevance of the surface sediment data was evaluated along the perimeter of the Interim Project Area. Each of the perimeter surface grabs within the navigation channel were collected by NW Natural in 2011 pursuant to the EPA-approved *Project Area Identification Report and Data Gaps Quality Assurance Project Plan – Gasco Sediments Cleanup Action* (Anchor QEA 2010b). These data are considered appropriate for remedial design decision-making.

3.1.1.1.4 Data Density

For the purposes of remedial design at the Gasco Sediments Site, NW Natural is targeting the collection of surface sediment grabs within the Interim Project Area at approximately 150 feet apart to maintain consistency with the subsurface DOC sediment core density described in Section 3.4. NW Natural evaluated the surface sediment data density relative to the updated RAL focused COC and PTW-highly toxic threshold natural neighbor exceedance contours to determine if areas exist where the contours were extrapolated across areas with insufficient data density. As shown in Figure 3, in the downriver channelward portion of the Interim Project Area, the RAL exceedance contour bulges slightly outside of the PTW-NAPL boundary due to interpolation between two adjacent surface sediment locations that are approximately 200 feet apart, one of which contains a TPAH RAL exceedance and one of which does not. A single additional three-point composite sediment grab is proposed at the approximate midpoint of these two locations to increase the data density in this area and minimize the interpolation distance. Similarly, just channelward and further upriver in this same area, the existing grabs are separated by greater than 150 feet and the Interim Project Area is governed by the PTW-NAPL boundary. Therefore, two additional three-point composite sediment grabs are proposed in this area.

NW Natural also evaluated the surface sediment data density within the channel portion of the Interim Project Area that will not impact refinement of the Interim Project Area (i.e., areas that are already sufficiently laterally bounded channelward by RAL or PTW-highly toxic threshold exceedances). NW Natural proposes the analysis of the full ROD Table 21 COCs in the 0- to 1-foot core interval (not a three-point composite sediment grab) in the four DOC cores identified in Figure 3.

NW Natural also evaluated the surface sediment data density outside of the Interim Project Area to determine whether additional data are necessary to bound the perimeter of the Interim Project Area. This evaluation identified a single downriver area lacking sufficient data density within the navigation channel just channelward of the downriver ROD-identified capping area (Figure 3). A single three-point composite sediment grab (and subsurface sediment core, as discussed in Section 3.1.2) is proposed in this area to increase the data density and confirm whether this area should remain outside the Interim Project Area. This evaluation also identified a single upriver area just channelward of the upriver ROD-identified capping area that contained two co-located surface sediment samples collected on slightly different dates (October 2010 and April 2011) with significantly different TPAH concentrations (4,800 parts per billion [ppb] versus 190,000 ppb, respectively), the latter of which slightly exceeds the TPAH RAL (170,000 ppb). A single three-point composite sediment grab is proposed in this area (Figure 3) to determine the existing surface sediment concentrations and whether this area should be within the Interim Project Area.

3.1.1.2 Subsurface Sediment Cores

1. NW Natural used the following LOEs to assess the surface sediment defined boundaries of the Interim Project Area and determine if any additional subsurface sediment cores are recommended to refine the perimeter of the Interim Project Area and inform the remedial design due to subsurface impacts: PTW-NAPL boundary identified in the ROD supplemented with the additional PTW-NAPL visual observations during the additional subsurface sediment sampling identified in Section 3 under EPA-approved plans
2. The presence, if any, of subsurface sediment ROD Table 21 RALs and PTW-highly toxic thresholds exceedances surrounding the perimeter of the Interim Project Area that do not have co-located surface sediment exceedances but have the potential for future exposure based on chemical and physical characteristics
3. Data density along the perimeter of the Interim Project Area

3.1.1.2.1 PTW-NAPL Refinement

Consistent with Section 3.1 of the TEWP, NW Natural proposes to refine the PTW-NAPL boundary identified in the Draft EE/CA (Anchor QEA 2012a) and depicted in the ROD based on the collection of additional sediment cores (via 20-foot vibracores) along the inside perimeter of the Interim Project Area. As shown in Figure 4, the existing boundary is identified as the outer perimeter of cores that do not contain PTW-NAPL using the site-specific definition identified in Section 3.1.1. NW Natural proposes the collection of a total of 16 subsurface sediment cores in the locations shown in Figure 4 to evaluate refinement of the PTW-NAPL boundary and associated Interim Project Area. A single core will be advanced in each location to a maximum depth of 20 feet below mudline, and the full recovered depth will be visually observed for the presence of PTW-NAPL using the site-specific definition. If any of these cores do not contain PTW-NAPL, the PTW-NAPL boundary will be adjusted to be coincident with the sampling location(s).

3.1.1.2.2 RAL Focused COC and PTW-Highly Toxic Threshold Exceedances Surrounding Perimeter of Interim Project Area

NW Natural compared the subsurface sediment concentrations surrounding the entire perimeter of the Interim Project Area to the ROD Table 21 RAL (Appendix E Figure E-1) and PTW-highly toxic thresholds (Appendix E Figure E-2) to determine if exceedances within the Interim Project Area are laterally bounded and if exceedances outside the Interim Project Area have the potential for future exposure (i.e., buried contamination) based on chemical and physical characteristics. NW Natural evaluated the potential for future exposure of subsurface sediments by comparing the following bathymetry surveys within the vicinity of the Gasco Sediments Site: 2003 to 2004, 2004 to 2009, 2009 to 2011, 2011 to 2014, 2014 to 2018, and 2003 to 2018. These chemical and physical evaluation results are shown in Appendix E Figures E-3a and E-3b. This comparison showed the ROD-identified Interim Project Area is sufficiently laterally bounded for remedial design, except in two small areas.

The first area is just channelward of subsurface sediment locations LW2-C525 and LW2-C264 within the downriver portion of the Interim Project Area. As shown in Appendix E Figures E-1 and E-2, these locations contain variable RAL and PTW-highly toxic threshold exceedances for multiple COCs at multiple depths below mudline. Of these two locations, location LW2-C525 is not laterally bounded towards the navigation channel, so NW Natural proposes a single core within the navigation channel outside of the Interim Project Area, co-located with the proposed three-point composite grab sample for additional data density in this area (Section 3.1.1.1). The second area is slightly further upriver within the navigation channel co-located with LW2-C258 outside the Interim Project Area. The existing core at this location contains TPAH RAL exceedances from 1 to 5 feet and 5 to 9 feet. As shown in Appendix E Figures E-3b, this location showed minor negative (erosion) bathymetry changes (-0.99 to -0.5 feet) when comparing the 2003 to 2018 bathymetry surveys, so NW Natural proposes a single core co-located with this location. The proposed sampling depths and analytes at these locations are described in Section 3.6 and depicted on Figure 13.

There are also variable RAL and PTW-highly toxic threshold exceedances at the following locations within or just outside the Interim Project Area that do not require additional cores to support Interim Project Area refinement: GS-C2, LW2-C276, WR-VC-50, WR-VC-56, LW2-C314, SD072, and J_49-BJ. No additional subsurface sediment cores are necessary to support refinement of the Interim Project Area at these locations for the following reasons:

- GS-C2, LW2-C276, and WR-VC-50: These samples are located within the Interim Project Area. NW Natural has already proposed the collection of two bounding cores channelward of these locations within the Interim Project Area to confirm the current boundary. The proposed sampling depths and analytes at these locations are described in Sections 3.2 and 3.4 and depicted on Figures 4 and 5. As shown in Appendix E Figures E-3a and E-3b, none of these proposed additional core locations are in areas that have experienced erosion (blue-green shading) for any of the survey comparisons completed between 2003 and 2018, indicating that any potential identified subsurface RAL or PTW-highly toxic threshold exceedances in these areas would not be exposed as surface sediments due to erosional processes.
- WR-VC-56 and LW2-C314: These locations contain RAL exceedances for DDx and PTW-highly toxic threshold exceedances for PCBs and DDx, respectively, neither of which are related to historical or current operations at the Gasco and Siltronic properties. The RAL and PTW-highly toxic exceedances at WR-VC-56 occur in the composite interval from 0 to 8.7 feet.

NW Natural does not propose the collection of cores in the vicinity of WR-VC-56 due to the lack of any RAL or PTW-highly toxic exceedances in the adjacent LW2-C314 from the 0- to 1-foot and 1- to 4.3-foot intervals and no identified erosion at this location for any of the survey comparisons completed between 2003 and 2018 (Appendix E Figures E-3 and E-4). Similarly, NW Natural does not propose the collection of any cores in the vicinity of LW2-C314 for the same reasons.

- SD072 and J_49-BJ: These locations are bounded in the upriver direction by the EPA-identified B2 project area shown on Figure 2, so any necessary pre-remedial design sampling and associated remedial action in this area will occur as part of the B2 sediment remedy.

3.1.1.2.3 Data Density

Consistent with the target surface sediment grab density described in Section 3.1.1.1.4, for the purposes of remedial design at the Gasco Sediments Site, NW Natural is targeting the collection of subsurface sediment cores within the Interim Project Area at approximately 150 feet apart. NW Natural evaluated the subsurface sediment core density surrounding the perimeter of the PTW-NAPL boundary to determine if this density is achieved. This evaluation only identified a single downriver area outside the Interim Project Area lacking sufficient data density within the navigation channel just channelward of the downriver ROD-identified capping area (Figure 3). As discussed in Section 3.1.1.2.2, NW Natural is already proposing the collection of a single subsurface sediment core in this area co-located with a three-point composite sediment grab, so no additional subsurface sediment cores are necessary to achieve the target subsurface data density.

3.1.2 Interim Project Area Refinement Evaluation Data Collection Methods

Vertical sampling depths and associated chemical analyses will be performed as follows using the procedures described in the *Pre-Remedial Design Data Gaps Field Sampling Plan* (Appendix A) and the *Pre-Remedial Design Data Gaps Quality Assurance Project Plan* (Appendix B):

- **Surface Grabs.** Consistent with the methods identified in the Pre-RD AOC Group's *Surface Sediment Field Sampling Plan, Portland Harbor Pre-Remedial Design Investigation and Baseline Sampling, Portland Harbor Superfund Site* (AECOM and Geosyntec 2018), surface grabs will be collected via a three-point composite from 0 to 1 foot below mudline and analyzed for the ROD Table 21 focused COCs and PTW-highly toxic additional contaminants. Each grab will also be visually logged for the presence of PTW-NAPL using the site-specific definition.
- **Subsurface Cores.** Core tubes will be advanced to a maximum depth of 20 feet below mudline or to refusal using a vibracore deployed from a vessel. Based on a comprehensive review of core recoveries obtained for the cores collected within the Interim Project Area, NW Natural proposes a core recovery acceptability criterion of 70%. Each core will be visually logged for the presence of PTW-NAPL throughout the full penetration depth using the site-specific definition. No chemical analyses will be performed on these cores for the purposes of Interim Project Area

refinement. However, chemical analyses will be performed in variable depths of these cores and additional cores to support the DOC, capping demonstrations, barge dewatering, and dredge material waste suitability characterization analyses described in the remainder of Section 3.

3.2 Capping Demonstration Evaluation

As detailed in the TEWP, the purpose of the capping demonstration evaluation is to describe the design processes that will be used to demonstrate the suitability of caps in the Final Project Area. Figure 5 shows a conceptual isolation cap cross section with design evaluation data uses for each cap component, listed as follows:

- **Habitat Layer:** Per the ROD, a surficial layer of habitat material is required as the top layer of any caps placed in the shallow region. No data gaps sampling activities are proposed for this layer, as the appropriate material type and thickness will be determined during the remedial design process in coordination with EPA.
- **Erosion Resistance Layer:** Consistent with Section 4.1.5 of the TEWP, no data gaps sampling activities are proposed for this layer. The need for an erosion resistance layer and design, if necessary, will be evaluated during the evaluation of data sources described in Section 2.1.2 and modeling calculations described in Section 4.1.5 of the TEWP.
- **Geotechnical Filter Layer:** No data gaps sampling activities are proposed for the geotechnical filter layer. If this layer is necessary to prevent fine-grained chemical isolation layer materials from migrating upward through pore spaces in the overlying coarse-grained erosion resistance layer, the gradation of the underlying chemical isolation materials and erosion resistance layer materials will be used to design the filter layer.
- **Chemical Isolation Layer:** Per Section 4.1.3 of the TEWP, the chemical isolation layer will be designed using porewater concentrations and measured groundwater seepage rates in the Final Project Area. Groundwater seepage rates and collocated bulk sediment and porewater samples were collected during two interim sampling events by NW Natural in fall 2017 and spring 2018 (results discussed in Appendices C and D of the TEWP). Porewater concentrations will be calculated from bulk sediment core data based on site-specific and literature-derived equilibrium partition coefficients. In areas where PTW-NAPL is present, site-specific measurements of dissolved phase chemical concentrations will be used to define porewater concentrations. Proposed data gaps sampling activities that will further inform chemical isolation layer design are presented in Section 3.2.1. Note that no data gaps sampling is necessary to inform the contaminant physical isolation layer; the required minimum thickness is included in Section 4.1.3.1.2 of the TEWP.
- **NAPL Reactive Layer:** Consistent with ROD Section 14.2.9.1, the cap may include a reactive layer in areas containing PTW-NAPL, PTW-NRC, PTW-highly toxic, or contaminated groundwater migration, if necessary, based on site-specific remedial design evaluations. It is expected that caps that may be placed in the PTW-NAPL area will require a PTW-NAPL

reactive layer. As discussed in Section 4.1.3.3 of the TEWP, PTW-NAPL loading can be estimated by understanding three PTW-NAPL transport mechanisms: advection, gas ebullition-facilitated transport, and sediment consolidation (squeezing) following cap placement. Proposed data gaps sampling activities that will inform the three PTW-NAPL transport mechanisms are presented in Section 3.2.2.

- **Underlying Sediment:** As discussed in Sections 4.1.5 and 4.1.6 of the TEWP, sediment geotechnical parameters will be used to design caps and inform cap placement requirements to account for slope stability and bearing capacity concerns and post-placement consolidation. Proposed data gaps sampling activities associated with cap geotechnical design are presented in Section 3.2.3.

The following subsections provide additional detail for the capping demonstration components with identified data gaps field sampling activities.

3.2.1 Chemical Isolation Components

A cap needs to provide sufficient chemical isolation to prevent chemical breakthrough into, and recontamination of, the biologically active zone at concentrations greater than the groundwater cleanup levels listed in ROD Table 17. As discussed in Section 4.1.3.2.1.2 of the TEWP, the chemical isolation model will be run for 100 years for determination of the long-term effectiveness of the cap. This section includes a summary of the data gaps sampling objectives and the data collection approach to satisfy the data gaps identified in Section 4.1.3.2.2 of the TEWP.

3.2.1.1 Chemical Isolation Components Data Gaps Sampling Objectives and Sampling Design

The data gaps sampling objectives will support capping evaluation(s) using the multiple LOEs described in the following subsections.

3.2.1.1.1 Porewater Concentrations Calculated from Bulk Sediment

This LOE includes the collection of additional cores for bulk subsurface sediment chemical analyses and subsequent calculation of porewater concentrations using empirically derived and site-specific or literature-derived equilibrium partitioning coefficients. The resulting site-specific porewater concentrations will be used as input parameters for the cap design model.[2] The sampling objective for this LOE at each core location is to measure bulk sediment concentrations approximately 4 feet below the pre-cap surface elevation, unless PTW-NAPL is identified at deeper depths, in which case deeper samples will be collected from the underlying PTW-NAPL depth interval(s). The pre-cap (and post-removal, in areas) surface elevations and PTW-NAPL elevations throughout the Interim Project

[2] A slightly different site-specific approach will be used in areas with PTW-NAPL; the sampling to support that approach is described in Section 3.2.1.2.3.

Area cannot be determined until completing data gaps sampling and performing the technical evaluations described in the TEWP. However, the range of pre-cap surface elevations can be estimated to support data collection throughout the Interim Project Area based on the following summarized ROD requirements:

- **Navigation Channel:** Section 14.2.1 of the ROD states, "If RALs are not achieved or PTW is present below the feasible depth limit of the excavation technology, as approved by EPA, a cap is assumed to be placed after dredging, as described in Section 14.2.9, Design Requirements, and per the decision tree in Figure 28 in Appendix I." Section 14.2.9.1 of the ROD then states, "Any proposed capping in the navigation channel and future maintenance dredge areas will consider the current and authorized channel depth, the potential for an increase to the currently authorized channel depth, future navigation and maintenance dredging, and an appropriate buffer depth to ensure the integrity of the cap." Section 2.1 of the ROD also states, "In 1999, Congress authorized the Willamette River to be deepened to 43 feet (Columbia River Datum [CRD]); however, this has not yet occurred." For the purposes of this Work Plan, a 3-foot buffer depth[3] is assumed for navigation channel maintenance dredging overdredge tolerance, and a cap thickness is assumed to be 4 feet. Applying these adjustments and converting CRD to City of Portland (COP) Datum (COP = CRD + 3.1 feet) results in a maximum pre-cap surface elevation in the channel of -47 feet COP (i.e., capping is deemed feasible in the navigation channel if the DOC extends deeper than -47 feet COP).

  As shown in Figure 6, NW Natural proposes to collect 35 cores throughout and immediately adjacent to the Interim Project Area within the navigation channel spaced approximately every 75 to 150 feet to characterize the lateral and vertical sediment conditions within the Interim Project Area. The specific location for each of these cores is based on the rationale described in Section 3.4 for the DOC cores. Each core will be subsampled in successive 2-foot sediment composite intervals starting at -47 feet COP and continuing to the full core recovery depth. These composite sediment samples will be submitted for chemical analysis of polycyclic aromatic hydrocarbons (PAHs), volatile organic compounds (VOCs), and arsenic using a tiered approach based on the screening analysis presented in Appendix D of the TEWP. VOCs have a 14-day analytical hold time, so each 2-foot sediment interval within each core will immediately be analyzed for the VOCs with ROD Table 17 with groundwater cleanup levels. The VOC samples will be collected expeditiously within the 2-foot interval prior to homogenizing the sample. After the VOC sample is collected, each 2-foot interval will be composited and subsampled for the full list of 17 PAHs and arsenic, and archived at the

[3] Section 14 of the ROD states, "Within the navigation channel, Alternative F Mod uses Alternative B RALs and all PTW is excavated or dredged 2 to 3 feet below the authorized dredge depth as an overdredge allowance/buffer zone. If RALs are not achieved or if PTW is found below the feasible depth of dredging or excavation, as determined by EPA, dredging to accommodate a cap and 2- to 3-foot overdredge allowance will occur." NW Natural elected to use the conservative upper end of the overdredge allowance range presented in the ROD.

laboratory pending potential analyses if the DOC analyses show RAL or PTW-highly toxic threshold exceedances or the presence of PTW-NAPL deeper than -47 feet COP.

- **Outside the Navigation Channel in the Intermediate Region:** Section 14.2.3 of the ROD states, "The intermediate region is defined as outside the horizontal limits of the navigation channel and FMD [future maintenance dredge] areas to the riverbed elevation of approximately -2 feet CRD [+1.1 feet COP]. […] NAPL or PTW that cannot be reliably contained will be dredged unless it is below the feasible depth limit of excavation technology, in which case it will be capped as described in Section 14.2.9, Design Requirements, and as approved by EPA." Unlike for the navigation channel, these requirements allow for a more flexible pre-cap surface elevation based on the multiple LOEs capping demonstrations identified in Section 4.1 of the TEWP and application of the remedial technology application decision tree identified in ROD Figure 28.

  As shown in Figure 6, NW Natural proposes to collect 33 cores throughout the Interim Project Area within the intermediate region spaced approximately every 75 to 150 feet to characterize the lateral and vertical sediment conditions within the Interim Project Area. Each core will be subsampled in successive 2-foot composite sediment intervals from the existing mudline to the bottom depth of the core. Consistent with the analyte list for the navigation channel cores based on the preliminary screening analysis in Appendix D of the TEWP, each composite sediment interval will be analyzed for PAHs, VOCs, and arsenic. However, unlike for the navigation channel cores, each composite sediment interval from each core will be immediately analyzed for PAHs (full list of 17 PAHs), VOCs (only those VOCs with ROD Table 17 with groundwater cleanup levels), and arsenic because the pre-cap elevation is unknown and capping does not depend on the DOC results.

- **Outside the Navigation Channel in the Shallow Region:** Section 14.2.4 of the ROD states, "The shallow region is defined as shoreward of the riverbed elevation of approximately -2 feet CRD [+1.1 feet COP]. [...] Contaminated sediment in this area will be dredged to the depth required to remove all NAPL or PTW that cannot be reliably contained (see Table 21 in Appendix II), unless it is below the feasible depth limit of excavation technology, in which case it will be capped as described in Section 14.2.9, Design Requirements, and as approved by EPA in accordance with the decision tree shown in Figure 28 in Appendix I. Where PTW is not present but the depth of excavation to achieve RAL concentrations is greater than 5 feet, the area will be dredged to 5 feet, with placement of a cap and backfilled to grade (capped per design requirements in Section 14.2.9, Design Requirements)." Consistent with the intermediate region, these requirements allow for a more flexible pre-cap surface elevation based on the multiple-lines-of-evidence capping demonstrations identified in Section 4.1 of the TEWP, with the added requirement to dredge to 5 feet in areas lacking PTW but with DOCs greater than 5 feet.

As shown in Figure 6, NW Natural proposes to collect 19 cores throughout the Interim Project Area within the shallow region spaced at approximately every 75 to 150 feet to characterize the lateral and vertical sediment conditions within the Interim Project Area. The specific location for each of these cores is based on the rationale described in Section 3.4.2 for the co-located DOC cores. Based on the ROD requirements listed herein, undetermined pre-cap surface elevations, and the limitation to dredge only to 5 feet if PTW is absent or present with a DOC greater than 5 feet but can be reliably contained, each core will be subsampled in the following successive intervals: 0 to 2 feet, 2 to 5 feet, 5 to 7 feet, 7 to 10 feet, and 10 to 13 feet. While logging a core, if PTW-NAPL is identified below 13 feet, sampling will continue in consecutive 2-foot composite sediment intervals to the bottom penetration depth of the core. Consistent with the analyte list and analytical sequencing for the intermediate region cores, each composite sediment interval will be analyzed immediately for PAHs, VOCs, and arsenic as the pre-cap elevation is unknown and the DOC is assumed to be greater than 5 feet based on review of the existing data.

The existing bulk subsurface sediment dataset will also be used to support the capping demonstration evaluations described in Section 4.1 of the TEWP.

3.2.1.1.2 Paired Bulk Subsurface Sediment and Co-Located Porewater Samples to Develop Site-Specific Equilibrium Partitioning Coefficients for VOCs

Appendix D of the TEWP explains that PAHs, VOCs, and arsenic are anticipated to drive cap design. Bulk surface sediment and porewater samples collected during the *Revised NW Natural Proposed Spring 2018 Interim Pre-Remedial Design Data Gaps Field Sampling – Gasco Sediments Site* (Anchor QEA 2018a) produced concentrations below detection limits at all 12 sampling locations for 8 of the 10 VOCs with ROD Table 17 groundwater cleanup levels. Therefore, Appendix D of the TEWP identifies additional bulk sediment samples collected from cores co-located with subsurface porewater samples and the analyses of the samples for VOCs containing ROD Table 17 groundwater cleanup levels to determine site-specific equilibrium partitioning coefficients for the applicable VOCs.

NW Natural proposes to collect 12 paired subsurface sediment and porewater locations based on review of the existing bulk subsurface sediment and porewater/groundwater VOC concentrations (represented by benzene, trichloroethene [TCE], and vinyl chloride) within the Interim Project Area, as shown in Appendix F, Figures F-1a through F-1f and Figures F-2a through F-2c. The proposed locations are identified in areas containing a representative range of VOC bulk sediment and porewater concentrations. Based on review of the existing subsurface VOC concentrations throughout the Interim Project Area, the paired samples will be collected from 4 to 6 feet below the mudline in the intermediate region and 5 to 7 feet below mudline in the shallow region.

Based on EPA's comments (Appendix K), both the bulk sediment samples and porewater samples will be analyzed for the full suite of VOCs, not only those that contain ROD Table 17 groundwater cleanup levels. The porewater sample will also be analyzed for dissolved organic carbon.

3.2.1.1.3 Subsurface Porewater Samples in Contact with PTW-NAPL Sediments

In contrast to the bulk sediment and porewater VOC sampling discussed in Section 3.2.1.1.2, this LOE includes the collection and chemical analysis of subsurface porewater samples from depth intervals containing PTW-NAPL. These additional porewater samples will not be used to develop equilibrium partitioning coefficients; rather, they will be used to characterize porewater PAH and VOC concentrations in contact with PTW-NAPL. These data will be used to define cap model inputs for porewater concentrations in areas containing PTW-NAPL (note that dissolved porewater concentrations are to be addressed by these samples, and the NAPL product advection is to be addressed separately, as described in Section 3.2.2). These data will also provide a means of defining upper limits for porewater concentrations calculated using partitioning coefficients from bulk sediment (e.g., samples having elevated bulk sediment concentrations that reflect NAPL influences that weren't identified as meeting PTW-NAPL criteria).

NW Natural proposes to collect up to five porewater samples from sediments containing a representative range of PTW-NAPL characteristics identified throughout the Interim Project Area. Factors/characteristics that will be evaluated to identify porewater sampling locations will include the texture of sediment containing PTW-NAPL (e.g., sand or silt), PTW-NAPL color differences (if any), and qualitative PTW-NAPL viscosity (relative rate of NAPL oozing or dripping out of the sediment sample during DOC core processing). Porewater sampling locations will coincide with PTW-NAPL depths and will cover a variety of these factors, thereby providing data across a representative range of site conditions. The proposed subsurface porewater locations and collection depths will be determined in the field based on the range of PTW-NAPL characteristics identified during processing of the DOC cores. Immediately following the completion of DOC cores and evaluation of PTW-NAPL observations, Anchor QEA will provide proposed porewater sampling locations, depths, and justification for each. NW Natural will request EPA's rapid review and approval to avoid scheduling delays. Consistent with Section 3.2.1.1.1 and based on the screening analysis presented in Appendix D of the TEWP, each subsurface porewater sample will be analyzed for PAHs and VOCs, as these chemicals are anticipated to drive the cap design. Based on EPA's comments (Appendix K), both the bulk sediment sample and porewater sample will be analyzed for the full suite of VOCs, not only those that contain ROD Table 17 groundwater cleanup levels. The porewater sample will also be analyzed for dissolved organic carbon. It is also anticipated that the selected locations and intervals will have co-located bulk sediment PAH and VOC concentrations measured to support the capping demonstrations discussed in Section 3.2.1.1.1.

3.2.1.1.4 Dissolved-Phase Transport Due to Cap Consolidation

Consolidation of the cap materials and the sediments underlying the cap can affect short-term advection and groundwater flow through the materials such that dissolved-phase chemicals may be transported due to cap consolidation. This evaluation will require the determination of the compressibility of sediments within the areas to be capped. A discussion of the proposed data gaps sampling objectives to support this evaluation is presented in Section 3.2.3.1.

3.2.1.2 Chemical Isolation Components Data Collection Methods

The following subsections summarize the proposed data collection methods for the chemical isolation LOEs for the capping demonstration. Sample collection methodologies and analytical testing are discussed in detail in the *Pre-Remedial Design Data Gaps Field Sampling Plan* (Appendix A) and *Pre-Remedial Design Data Gaps Quality Assurance Project Plan* (Appendix B).

3.2.1.2.1 Porewater Concentrations Calculated from Bulk Sediment

The proposed 91 total core locations proposed throughout the navigation channel, intermediate region, and shallow region will be collected using a vibracore outfitted with a 20-foot core barrel. Each core will be sectioned into the vertical intervals described in Section 3.2.1.1.1 and either collected using a t-bar sampler and placed in pre-labeled and pre-preserved volatile organic analysis vials (for VOCs) or homogenized and placed into sampling jars (for PAHs).

3.2.1.2.2 Paired Bulk Subsurface Sediment and Co-Located Porewater Samples to Develop Site-Specific Equilibrium Partitioning Coefficients for VOCs

The proposed 12 locations will each be sampled for subsurface porewater that is co-located with a bulk sediment core. The bulk sediment sample will be collected using a vibracore outfitted with a 20-foot core barrel. Each core will be sectioned into the vertical intervals described in Section 3.2.1.2.1. Consistent with EPA Method 5035, a non-homogenized VOC sample will be collected using a clean t-bar sampler from a discrete location within the target interval based on visual observations and placed into pre-labeled volatile organic analysis vials with sodium sulfate (2 vials) or methanol preservative (one vial). If sediment characteristics within the sample interval visually appear to be homogenous or heterogeneous but does not appear to contain visual impacts, the sample will be taken from the midpoint of the interval. However, if there is visual heterogeneity in sediment characteristics, the sample will be collected from the most visually impacted sediment within the sample interval. The "most visually impacted" sediment in the context of sampling is defined as sediments containing what appears to be the most mobile NAPL or tar based on field observations, if such sediment is apparent within the sample interval.

A separate Geoprobe drill rig deployed from a vessel will be used to collect the subsurface porewater samples slightly offset (maximum offset of 20 feet) from the sediment core location. The porewater samples will be collected by pumping porewater through a Geoprobe outfitted with a 2-foot screen interval advanced to the target depth interval. To the extent possible given the existing PTW-NAPL distribution, the proposed locations and depths are in areas with limited potential for containing PTW-NAPL. To eliminate the collection of the paired sediment and porewater samples from depth intervals containing PTW-NAPL or non-mobile forms of NAPL, visual monitoring for NAPL will be performed during core logging at each proposed location, and the sampling depth will be adjusted as necessary to a different 2-foot depth interval if mobile or non-mobile NAPL is identified in the target interval. As a preventative measure, the porewater samples will be collected through an inert, porous ceramic filter that will exclude NAPL from entering the sampling container.

3.2.1.2.3 Subsurface Porewater Samples in Contact with PTW-NAPL Sediments

Up to five subsurface porewater samples from sediment locations and depth intervals containing PTW-NAPL will be collected using the same Geoprobe drill rig used to collect subsurface VOC samples (see Section 3.2.1.2.2). Porewater will be pumped through a Geoprobe outfitted with a 2-foot screen interval advanced to a target depth interval that will be determined in the field based on visual observations of PTW-NAPL during logging of the DOC cores. Porewater samples will be collected through an inert, porous ceramic filter that excludes NAPL from entering the sampling container.

3.2.1.2.4 Dissolved-Phase Transport Due to Cap Consolidation

A discussion of the proposed sampling design to support this evaluation is presented in Section 3.2.3.2.

3.2.2 NAPL Mobility Testing

As discussed in Section 3.1 of the TEWP, PTW-NAPL is present within the Gasco Sediments Site where capping demonstrations will be completed during remedial design. The capping demonstrations will need to address the potential transport of the PTW-NAPL into the overlying cap materials. Section 4.1.3.3 of the TEWP presents the methods of analysis and associated data requirements and data gaps to characterize the potential for upward transport of PTW-NAPL.

3.2.2.1 NAPL Mobility Testing Data Gaps Sampling Objectives and Sampling Design

The following subsections describe the data gaps sampling objectives and sampling design for the following three PTW-NAPL transport mechanisms described in the TEWP: 1) PTW-NAPL loading via advection; 2) gas ebullition-facilitated transport of PTW-NAPL; and 3) PTW-NAPL transport to the cap from underlying, post-cap sediment consolidation.

3.2.2.1.1 PTW-NAPL Loading via Advection

The objective of characterizing PTW-NAPL transport via advection is to understand the potential flux of PTW-NAPL into overlying sediment via this transport mechanism. PTW-NAPL advection is the flow of continuously connected PTW-NAPL through sediment pore spaces due to hydraulic gradients and PTW-NAPL density/buoyancy forces. The potential flux of PTW-NAPL due to advection can be used to help identify the quantity of amendment (e.g., organoclay) in the cap (if any) to immobilize and sequester PTW-NAPL within a PTW-NAPL attenuation layer of the cap over the cap design life. This objective will be met through the following sequenced data collection steps:

1. During processing of the DOC cores (Section 4.4), bulk subsurface sediment from depth intervals containing PTW-NAPL will be subsampled, and these materials will be subject to large-scale shake tests to separate PTW-NAPL from sediment as an additional LOE for NAPL fluid properties testing.[4] During application of the large-scale shake test, surface tension characteristics cause either light nonaqueous phase liquid (LNAPL) or dense nonaqueous phase liquid (DNAPL) to create a separate layer at the interface between air and water in the vessel. The NAPL is collected by carefully decanting it into a separate container. The testing laboratory performs a further “cleanup” process that separates the NAPL from any incidental water or solid particles. Up to six NAPL samples are proposed to account for possible differences in NAPL composition and weathering in the Interim Project Area. The six samples will be collected from cores exhibiting a range of highly mobile NAPL (e.g., different colors, viscosities, and odors) in a range of sediment physical characteristics (e.g., sands and silts). The samples of PTW-NAPL will be analyzed for the following fluid properties: density, viscosity, wettability, and interfacial tension with water. These data may be useful to help characterize the PTW-NAPL flux due to advection. In addition, the PTW-NAPL samples will be analyzed for total petroleum hydrocarbon (TPH) to provide a basis to estimate NAPL volume from sheen net TPH data (discussed in Section 3.2.2.1.2). NW Natural proposes collecting up to five NAPL samples based on the nature of the PTW-NAPL observed during the core processing. Consistent with EPA comments on the June 10, 2019 version of the Work Plan (Appendix K), NW Natural also proposes the performance of the sampling methods described in this section at one location that has heavy sheening but does not meet the criteria for PTW-NAPL.
2. Co-located with each of the DOC cores subsampled for the bulk sediment containing PTW-NAPL described in Step 1, an additional single subsurface sediment core will be collected to a target depth (where achievable) of 2 feet below the subsampled PTW-NAPL depth interval. The unprocessed cores will be shipped on ice to a laboratory for testing of PTW-NAPL mobility using the methods described in Section 3.2.2.2.1.

[4] NW Natural will also be completing centrifugation of cores during the NAPL mobility testing discussed in Section 3.2.2. Anchor QEA has successfully collected pure NAPL samples from sediment cores at other sites using the proposed gentle shake-test method. If the NAPL is a dense nonaqueous phase liquid (DNAPL), centrifuging the material after gentle shaking could cause the NAPL to settle back into the sediment within the container, complicating separating the NAPL.

3. The following laboratory evaluations will be performed using the cores described in Step 2 (see Figure 7):
   a. White-light and ultraviolet-light photography will be used to identify the portion of the core with the most notable PTW-NAPL, which will be inferred to represent the highest NAPL saturation within the sediment pore space. A PTW-NAPL mobility test plug will be obtained from this portion of the core.
   b. The test plug will be characterized for NAPL mobility (i.e., the volume of NAPL drained from the core sample will be quantified, in addition to the final NAPL mass remaining in the sample), percent water saturation, percent initial and final NAPL saturation, capillary pressure, total porosity, grain density, dry bulk density, and grain size.
   c. The material overlying the test plug that does not contain NAPL will be characterized for the following parameters: capillary pressure, hydraulic conductivity, porosity, and grain size.

These subsurface sediment cores will be located within the PTW-NAPL footprint outside of the navigation channel because there is currently insufficient data to understand whether the DOC in the navigation channel is sufficiently deep to warrant capping. To be conservative, the sampling locations and depth intervals will be selected in the field based on the greatest potential for advective PTW-NAPL transport (e.g., pooled product in the core that oozes upon minimal disturbance).

3.2.2.1.2 Gas Ebullition-Facilitated Transport of PTW-NAPL

The objectives of quantifying gas ebullition-facilitated NAPL transport are as follows: 1) measure the existing PTW-NAPL mass flux and use it to help design the PTW-NAPL sequestration layer of a cap, where necessary; and 2) model the subsurface biogeochemical conditions underlying the post-dredge cap to understand the likely methane production zones below a cap placed on a newly dredged surface, which will inform the potential for gas ebullition to transport PTW-NAPL under future post-construction conditions. These objectives can be met by performing the following data collection steps:

1. Perform a series of observations throughout the Interim Project Area to understand the extents of gas ebullition, sheen blossoms (i.e., active surface sheening associated with gas ebullition), and static sheen (i.e., existing sheen without a known source). These observations will be used to determine the areas of the Interim Project Area that will be subject to the specific data collection described in bullets 2 and 3, and will consist of the following:
   - High-level scans will be performed throughout the entire Interim Project Area during low tide in late summer during two consecutive days. These scans will be performed by Anchor QEA staff in vessels and/or by aerial photography.

- Concurrent with the high-level scans, focused scans will be performed to zoom in on areas with the presence of sheen to confirm any area(s) with active sheen blossoms. If aerial photography is used for the high-level scans, Anchor QEA staff will confirm the findings from a boat by visually observing the areas of the Interim Project Area that appear to have active sheen blossoms. Once this area(s) is confirmed, the data collection methods described in LOE 1-3 in bullet 2 below will occur in the area(s) with observed active sheen blossoms.

2. Perform a multiple-LOE data collection approach to estimate the PTW-NAPL mass flux as follows:
   - **LOE 1:** Visual assessment of sheen production during summer months (conservative because higher surface water and sediment temperatures increase gas ebullition rates) in areas where active sheen blossoms have been observed.
   - **LOE 2**: Simultaneous video/photo recording of sheen production to be analyzed to estimate gas ebullition-related mass flux.
   - **LOE 3**: Limited collection of active sheen blossom samples concurrent with LOE 1 and LOE 2 data collection, and analysis of these samples for TPH to calibrate the sheen mass flux estimated based on visual and recorded observations.

3. Perform a laboratory microcosm study to measure biogas (methane) production rates as a function of the character and concentrations of organic carbon sources in preselected subsurface sediment core intervals. The results of this study will provide a range of input parameter values for a biogeochemical reactive transport model that will be used to evaluate biogas production and gas ebullition potential at locations where sheen has been previously observed and to assess the potential range of biogas production rates within the capping areas.

Laboratory analysis for purposes of developing input parameters for the biogeochemical reactive transport model will be performed on a subset of the locations and intervals (ten total) from the proposed DOC cores. The locations and depth intervals were selected to represent the range of variability in subsurface conditions with respect to organic carbon sources potentially supporting methanogenesis, including total organic carbon (TOC), TPAH, and TPH concentrations, measured during prior sampling programs. As shown in Appendix F, Figures F-3a through F-3f, samples will be collected from 4 to 6 feet below the mudline in the intermediate region and 5 to 7 feet below mudline in the shallow region. A subset of these sample locations are within the areas where sheen was previously observed and gas ebullition may have occurred (e.g., inside the sheen containment boom actively managed by NW Natural surrounding the outfall located on the Gasco-Siltronic property line). The DOC core at these locations will be split longitudinally and one half transferred immediately to a pre-labeled Mylar barrier bag. This sample container will be sealed with zero headspace and placed inside a second pre-labeled Mylar barrier bag with oxygen absorbent packets.

These samples will be analyzed for the following: TOC, PAHs (both parent and alkyl PAHs), TPH, chemical oxygen demand, labile organic carbon, intrinsic biogas production potential, moisture content, and grain size.

3.2.2.1.3 PTW-NAPL Loading to the Cap from Sediment Consolidation

The objective of quantifying PTW-NAPL loading to the cap from sediment consolidation is to understand the additional mass of PTW-NAPL, if any, that may be squeezed from pore spaces and migrate upward into the cap from the underlying sediment. This objective can be met by collecting geotechnical data from the underlying sediment, as detailed in Section 3.2.3.

3.2.2.2 NAPL Mobility Testing Data Collection Methods

The following subsections present the data collection methods to characterize the three potential PTW-NAPL transport mechanisms. Sample collection methodologies and analytical testing are discussed in detail in the *Pre-Remedial Design Data Gaps Field Sampling Plan* (Appendix A) and *Pre-Remedial Design Data Gaps Quality Assurance Project Plan* (Appendix B).

3.2.2.2.1 PTW-NAPL Loading from Advection

Where PTW-NAPL is observed in subsurface sediment cores located outside the navigation channel during DOC core processing, pure PTW-NAPL samples will be collected by separating PTW-NAPL from sediment using large-scale shake tests. In general, the shake test includes adding a specified volume of sediment containing visual observations of PTW-NAPL into a jar containing deionized water, inverting the jar for a short duration, and placing the jar on a flat surface and allowing the suspended sediments to settle and any present NAPL to form at either the sediment-water or air-water interfaces within the jar. The pure PTW-NAPL samples that successfully separated from the sediments will then be tested for density, viscosity, and/or interfacial tension with water, as well as TPH concentrations.

Laboratory NAPL mobility core testing will be performed on core intervals containing the most notable PTW-NAPL observations within multiple representative areas. One core will be collected per location and cut into 4-foot sections to be sent to the laboratory for NAPL mobility testing. Each core will be cut lengthwise and photographed under white and ultraviolet light in a laboratory to identify the depth of the most notable NAPL. Core sections containing the most notable NAPL will be subjected to centrifuge testing with hydraulic gradients equivalent to 25 times the force of gravity for 10 hours. The volume of NAPL drained from the soil core sample will be quantified, in addition to the final NAPL mass remaining in the sample. The laboratory will measure the volumes of NAPL and water produced using a calibrated collection receiver that is placed beneath each centrifuged sample. The NAPL volume remaining in the sample will be quantified by Dean-Stark extraction. The laboratory will also measure the total sample volume and the sample porosity, bulk density, and grain density. The lab will calculate and report the initial and final NAPL saturations.

3.2.2.2.2 Gas Ebullition-Facilitated Transport of PTW-NAPL

Visual observations and concurrent video recordings and photographs will be performed initially using aerial photographs and corroborated using field personnel in vessels and/or stationed along the riverbank. In an effort to collect the most conservative gas ebullition data (i.e., highest expected rates of gas ebullition), NW Natural proposes to perform the visual observations and data collection when the Willamette River is expected to have the lowest water levels of the year with warm temperatures. NW Natural, therefore, anticipates completion of the gas ebullition visual observation and associated sheen sampling at the end of September.

Visual observations and videos/photos will be used to estimate the rate of gas bubbles due to gas ebullition and the area of gas bubbles due to gas ebullition, and active sheen blossoms (i.e., number per minute or number per hour) and the area and color of visible active sheen blossoms. The sheen color will be used to estimate sheen thickness using ASTM F2534-06, and the area, thickness, and frequency of active sheen blossom observations will be used to estimate the sheen mass flux. Visible active sheen blossoms will be sampled using hydrophobic sheen nets and submitted to a laboratory for TPH analysis to quantify the mass of PTW-NAPL collected.

A sediment biogeochemical model will be used to assess the long-term gas ebullition potential across potential capping areas. The model is based on previously published work in peer-reviewed journals (e.g., Hunter et al. 1998, Bessinger et al. 2012) and will be adapted to simulate depth and time dependent microbial terminal electron accepting processes including methanogenesis that are driven by mineralization of organic matter (from both natural and fossil fuel derived sources) in sediment. With the model, biogas production rates and gas ebullition potential can be evaluated as a function of distribution and concentrations of organic carbon pools of differing lability, sediment depth, temperature, and porewater velocity. The model will be parametrized using the laboratory characterization data and testing described in Section 3.2.2.1.2 and other site-specific data and information.

The gas ebullition biogeochemical modeling sediment samples from the 4 to 6 feet and 5 to 7 feet depth intervals will be taken from the DOC core collected using a vibracore outfitted with a 20-foot core barrel. The laboratory microcosm study to measure biogas (methane) production potential will be measured using a modified batch anaerobic incubation method based on Esposito et al. (2012) and described in the Appendix A standard operating procedures.

3.2.2.2.3 PTW-NAPL Loading to the Cap from Sediment Consolidation

Data collected as part of the geotechnical components of the capping demonstration will provide the necessary information to design a cap to be protective of PTW-NAPL loading from sediment consolidation. The data collection approach for the capping demonstration geotechnical component is described in Section 3.2.3.

3.2.3 Geotechnical Components

As discussed in the TEWP, additional geotechnical data for the evaluation of slope stability (Section 4.1.7 of the TEWP) and bearing capacity, settlement, and seismically induced settlement (Section 4.1.8 of the TEWP) is required to inform remedial design in order to demonstrate the following:

- Dredge slopes and any adjacent structures or upland slopes will be stable.
- The cap and slope will be stable after material placement on slopes.
- Sediments can support the weight of a cap and allow the cap to provide physical and contaminant isolation as designed.
- Sediment elastic settlement or consolidation induced by cap placement will not adversely affect cap ability to provide physical and contaminant isolation as designed.
- Sediment elastic settlement or consolidation induced by cap placement will not adversely affect cap integrity or in-water structures.
- Settlement induced by cap placement or seismically induced settlement will not adversely affect cap ability to provide physical and contaminant isolation as designed.
- Settlement induced by cap placement and liquefaction-induced settlement will not adversely affect cap integrity.

This section includes a summary of the data gaps sampling objectives and sampling design and the data collection methods to satisfy the identified data gaps in Section 4.1.7.2 and 4.1.8.4 of the TEWP.

3.2.3.1 Geotechnical Components Data Gaps Sampling Objectives and Sampling Design

The data gaps sampling objectives of geotechnical evaluations are to support the capping and dredging evaluation(s) by considering the following:

- **Stability.** Short-term and long-term stability of nearby upland and onshore structures and slopes, in-water structures and slopes, and any potential sheetpile walls will be necessary to ensure the adequacy of proposed remedial design options and performance of the cap. This evaluation will require shear strength information of the soils and the development of subsurface profiles including soil stratification, shear strength, and material composition.
- **Bearing Capacity.** The weight of the cap material layers (based on the final remedial design) will need to be supported by the sediments it overlies. To verify that the sediments will be able to support the cap weight, bearing capacity evaluations will be done. This evaluation will require determination of the shear strength of sediments within the area to be capped.
- **Consolidation.** In general, caps can tolerate a high amount of total and differential settlement without compromising cap performance. However, consolidation of the cap materials and the sediments underlying the cap will affect short-term advection and groundwater flow through the materials and may impose additional loads onto existing

in-water foundation elements (piles). This evaluation will require the determination of the compressibility of sediments within the areas to be capped.

Geotechnical evaluations will be performed using both ex situ and in situ tests. Seventeen ex situ sonic core locations for standard penetration tests (SPTs) and ten in situ locations for cone penetration tests (CPTs) are proposed and shown in Figure 8 to support these geotechnical evaluations. The determination of these locations was based on the visual assessment of subsurface conditions noted on cross sections developed in prior work phases, spatial distribution of existing in-water explorations, potential remedial technologies applied to an area(s), the potential alignment for water quality containment engineering controls, conceptual locations for temporary and permanent retaining systems, proximity of utilities and structures, vessel access, and vessel traffic considerations. A general guidance of between 150 to 200 feet between geotechnical locations was used to provide representative horizontal spatial coverage.

For the sonic borings, one to five samples will be collected per core for geotechnical lab analysis depending on sediment thickness and lithology. Analyses include moisture content, Atterberg limits, grain size, specific gravity, dry bulk density, one-dimensional consolidation, direct shear strength, and triaxial shear strength. In addition, SPT blow counts will be recorded on field forms for every 5 feet of boring advancement. The SPT data will be used with published equations and relationships to correlate with geotechnical design parameters and approximate characteristics, such as material type, undrained shear strength, compressibility, and frictional strength. For the CPT borings, data will be continuously collected during testing as the probe is pushed into sediment, and no physical samples will be collected. Table 2 summarizes the use of the collected geotechnical data to complete the technical evaluations identified in the TEWP.

Moisture content, Atterberg limits, and grain size tests can be conducted on each sample, while dry bulk density, one-dimensional consolidation, direct shear strength, and triaxial shear strength tests will only be performed on undisturbed (Shelby tube) samples.

NW Natural is unaware of documented research that sonic drilling will disturb the sampling interval below the depth of drilling. To address the stated concern, SPT N-values will be checked against the CPT results to identify possible disturbance. This Work Plan was revised to include two locations where the SPT and CPT tests are performed at the same location to facilitate a direct comparison. Further, in situ and laboratory test results will not be treated as absolute values for design purposes but will be considered as one of several data points (including local experience in similar soil units and correlations with index parameters) when assigning appropriate design strength and compressibility parameters for Interim Project Area sediments. Finally, due to the presence of contamination at the Interim Project Area, alternative drilling methods, such as drive and wash or mud-rotary drilling, were not considered due to the significant challenge of managing drilling fluids as investigation-derived waste.

3.2.3.2 Geotechnical Components Data Collection Methods

The ex situ SPTs will be collected using a barge-mounted sonic drill rig and drill methods in general accordance with ASTM D6914. Sonic borings will be performed using a 3-inch inside-diameter split-spoon core sampler. Once the top of the SPT sample interval is reached, the split-spoon sampler will be used to perform the SPT and collect disturbed samples for testing. The SPTs are proposed starting at the mudline and continuing at 5-foot or 10-foot intervals until the termination of the boring. The in situ testing will be performed using CPTs with pore pressure measurement (CPTu) and full-flow penetration (FFP) tests using a barge-mounted direct-push drill rig. The CPTu and FFP are hydraulically pushed probes that collect data continuously as the probe is pushed through the sediment.

The termination depth for the SPTs, CPTu, and FFP tests at each proposed location will be determined by one of the following conditions, whichever is shallowest:

- 65 feet below the mudline
- Refusal based on equipment or sampling setup limitations for CPTu and FFP
- Physical equipment limitation or sampling setup (i.e., all sonic core casings or CPT rods available on a barge are already in use)

3.3 Riverbank Remedy Evaluation

Based on the ROD requirements for riverbank remediation outlined in Section 4.3 of the TEWP, NW Natural will determine the need for riverbank remediation adjacent to the Gasco Sediments Site based on evaluations of the presence of PTW-NAPL, and ROD Table 21 RAL and PTW-highly toxic/NRC (PTW-NRC thresholds, if any, will be based on the site-specific capping demonstration evaluation described in Section 4.1 of the TEWP) threshold exceedances, the potential for sediment recontamination due to riverbank soil erosion, and riverbank slope stability for the remedy post-construction condition. Per ROD Figure 28, monitoring is a suitable remedy in areas without PTW-NAPL/NRC, where existing erosion protection is shown to be adequate. This section includes a summary of the data gaps sampling objectives and the data collection approach to satisfy the data gaps identified in Section 4.3.6 of the TEWP.

Sample collection methodologies and analytical testing are discussed in detail in the *Pre-Remedial Design Data Gaps Field Sampling Plan* (Appendix A) and *Pre-Remedial Design Data Gaps Quality Assurance Project Plan* (Appendix B).

3.3.1 Riverbank Remedy Evaluation Data Gaps Sampling Objectives and Sampling Design

As discussed in Section 4.3.6 of the TEWP, existing data is primarily located at the top of the riverbank and in-water at the toe of the slope with limited available information on the sloping riverbank because conditions on the slope render it inaccessible for sampling. This limited data impacts NW Natural's ability to perform the necessary riverbank remedy evaluations described in the TEWP. To fill this data gap, additional soil samples will be collected to characterize the wedge of riverbank soil material between the toe of slope and the top of the riverbank. This data will be used to inform the following remedial design evaluations for the riverbank remedy:

- Estimated vertical and lateral extents of PTW-NAPL/NRC, PTW-highly toxic, RAL, and riverbank soil/sediment cleanup level exceedances in the riverbank
- Lateral extent of riverbank that passes the erosion evaluation identified in the ROD technology tree
- Justification for the remediation technologies based on erosion and presence of contamination
- Bulk sediment data to support the riverbank capping demonstration
- Excavation/dredge material waste suitability determinations (discussed in Sections 3.5.1.2 and 3.5.2.2)

The eight boring locations on the Gasco property shown in Figure 9 are proposed based on their location downgradient from uplands areas containing DNAPL in the Fill Water-Bearing Zone (based on data presented in the *Interim Feasibility Study for the Former Gasco Manufactured Gas Plant Operable Unit* [Anchor QEA 2018b]) and to achieve approximately 200-foot horizontal spacing across the Gasco property. Four angled riverbank borings, also shown in Figure 9, will be collected along the top of the Siltronic riverbank using consistent sampling methods and chemical analyses proposed on the Gasco property. As described in Section 3.2.2, each boring will be collected at an angle from the top of the riverbank to access soils/sediments below the riverbank that are inaccessible on the surface due to heavy armoring, dense vegetation in some areas, and a steep slope.

The proposed bottom depth of each boring will be at least as deep as the elevation of the closest downgradient sediment sampling location shown in Figures 10a-b. For VOCs, a single discrete sample will be collected from the portion of each of the three sample intervals (total of three VOC samples) that looks to be most visually contaminated, as described in Section 3.2.1.2.2, from 0 to 10 feet, 10 to 20 feet, and 20 feet to the elevation of the closest downgradient sediment sampling location. For all other analytes, the sample intervals (0 to 10 feet, 10 to 20 feet, and 20 feet to the elevation of the closest downgradient sediment sampling location) will be homogenized across the entire sample interval (three intervals per location, except where the elevation of the closest downgradient sediment sampling location is shallower than the 20-foot interval). Locations and descriptions of PTW-NAPL will be recorded, if observed, throughout the entire length of the core. Each of the sample depth intervals will be composited individually and analyzed for compounds listed in Table 17 of the ROD with a groundwater cleanup level, for compounds listed in Table 17 of the ROD with a riverbank soil/sediment cleanup level, and for ROD Table 21 RALs and PTW-highly toxic thresholds.

3.3.2 Riverbank Remedy Evaluation Data Collection Methods

Multiple sample collection methodologies were considered for collecting soil samples along the heavily armored riverbanks adjacent to the Gasco and Siltronic properties. Due to a variety of issues (access, vibration, presence of source control equipment and other structures, etc.), it was determined that advancing angled borings from the top of the riverbank was the safest and most practical sample collection methodology. The target locations may need to be adjusted based on contractor access. The drill rig will be set up so the core barrel enters the ground at an angle approximating the angle of the riverbank slope, but it will be no less than 45 degrees and no more than 90 degrees. This angle will be confirmed in the field using an inclinometer. Continuous soil samples will be obtained and sampled at the target frequency and depth intervals. To account for the angled boring, the target bottom depth interval will be calculated as the vertical distance from the ground surface if the core barrel was oriented perpendicular to the ground surface. The entire recovered depth of riverbank soils will be logged and visually assessed for the presence of PTW-NAPL using the site-specific definition. Soil borings will be abandoned using the approach approved at the upland Gasco property by the Oregon Department of Environmental Quality (DEQ) and Oregon Water Resources Department (Bayuk 2009).

3.4 Dredging Evaluation

The primary goal of the dredging evaluation is to develop a three-dimensional dredge prism design in dredging and cover and dredge and cap areas, as determined through the ROD decision framework (and associated evaluations discussed in Sections 4.1 and 4.2 of the TEWP). In dredge and cover areas, the three-dimensional dredge prism should achieve removal, to the extent practicable, of the full extent of RALs, PTW-highly toxic/NRC (if applicable) thresholds, and PTW-NAPL. In dredge and cap areas, the three-dimensional dredge prism design should achieve removal to the design depth or elevation prior to cap placement. In addition, the dredging evaluation will support the identification of dredge management units (DMUs). The dredge prism design will consider the performance standards and design objectives presented in TEWP Section 4.2.1.

This section includes a summary of the data quality objectives and the data collection approach to satisfy data gaps identified in Section 4.2.7 of the TEWP. The post-dredge residual management approach is included as Appendix E of the TEWP. Sample collection methodologies and analytical testing are discussed in detail in the *Pre-Remedial Design Data Gaps Field Sampling Plan* (Appendix A) and *Pre-Remedial Design Data Gaps Quality Assurance Project Plan* (Appendix B).

3.4.1 Dredging Evaluation Data Gaps Sampling Objectives and Sampling Design

A significant amount of existing data in the Interim Project Area boundary will be used to support the remedial design dredging evaluations. However, much of the existing subsurface data was collected in relatively large depth intervals (e.g., composited in 4-foot increments) and/or the DOC is vertically unbounded (i.e., bottom collected sample interval exceeds RALs or PTW-highly toxic thresholds or contains PTW-NAPL), which may be insufficient for remedial design evaluations. Additional subsurface sediment data collection is proposed to better define the DOC to support remedial design within the Interim Project Area, determine the appropriate remedial technologies throughout the Interim Project Area using the ROD Figure 28 technology application decision tree, further refine the lateral and vertical extents of PTW-NAPL, and develop a three-dimensional dredge prism (and subsequent determination of DMUs) in dredge and cover and dredge and cap areas.

Seventy-two DOC core locations are proposed within the ROD-identified dredge and cover and dredge and cap areas located in the Interim Project Area (shown in Figure 4 along with historic core locations). If the capping demonstration cores located in the upriver and downriver portions of the Interim Project Area outside of the current PTW-NAPL boundary identify the presence of PTW-NAPL, the DOC will be identified in those cores as well. As detailed in Appendix E of the TEWP (*NW Natural's Additional Revised Gasco Sediments Site Dredge and Cover Design, Implementation, Verification, and Closeout Approach Memorandum*), NW Natural proposes a sediment core sampling density of approximately 100 to 125 feet on-center to adequately characterize the spatial physical and chemical heterogeneities within the Interim Project Area and minimize the risk of encountering and managing post-dredge missed inventory (i.e., contaminated sediment remaining below the post-dredge surface) in dredge and cover areas.

It is important to recognize that subsurface sediment contamination may extend deeper than may be achievable in the Interim Project Area using the conventional coring method summarized in Section 3.4.2. Determining the DOC is required as necessary to support remedial technology assignments consistent with the ROD Figure 28 technology application decision tree and to complete the subsequent remedial design evaluations described in Sections 4.1 (capping demonstration evaluations) and 4.2 (dredging evaluations) of the TEWP. As shown in ROD Figure 28 and described in Section 14.2 and its associated subsections, there are several scenarios where the DOC is not required due to the flexibility to cap following dredging. These scenarios include when RALs are below the feasible depth of excavation; when the design is in close proximity to functional structures or riverbank: when RAL exceedances are greater than 5 feet in the shallow region in the absence of PTW-NAPL; and, when the RAL and PTW-highly toxic/NRC [if applicable] threshold exceedances can be reliably contained. Based on this ROD flexibility, NW Natural proposes the advancement of 20-foot cores, the maximum length available for the proposed coring technology. Deeper cores using a different drilling technology will be considered in a subsequent phase of work for elevated chemical mass inventory purposes if remedial design objectives are met with the 20-foot cores but DOC remains unbounded in some areas.

Consistent with the EPA *Portland Harbor Superfund Site – Remedial Design FAQ Document* (EPA 2018), the DOC will be determined by collecting subsurface sediment cores and sampling them consecutively in 1-foot intervals from the bottom recovered sample depth upwards through the core until no RAL or PTW-highly toxic/NRC (if applicable) threshold exceedances are identified and no PTW-NAPL is present. The DOC will be defined as the bottom depth/elevation of the deepest sampled depth interval containing RAL or PTW-highly toxic/NRC (if applicable) threshold exceedances and no PTW-NAPL present.

3.4.2 Dredging Evaluation Data Collection Methods

The proposed subsurface sediment samples will be collected using vibratory core sampling (vibracore) methods deployed from a vessel. The vertical sampling and analysis at each core location will be performed at the following multiple successive depth intervals below mudline:

- Two successive 1-foot intervals will be analyzed beginning at the bottom depth of recovery to understand the DOC for the full suite of ROD Table 21 focused COCs. The remaining sediments will be archived in one-foot intervals to be triggered as necessary to determine the DOC in each core. The "bottom-up" sampling approach is described in the following bullets:
- If either interval at the bottom depth of recovery exceeds any of the ROD Table 21 focused COCs or contain NAPL, the core will be considered unbounded and the DOC will be evaluated by the DOC decision framework presented in Section 3.4.1. As discussed in EPA's *Portland Harbor Superfund Site – Remedial Design FAQ Document* (EPA 2018), two consecutive clean 1-foot intervals are required to establish a DOC within a sediment core.
- If neither of the two sampled 1-foot intervals exceed any of the ROD Table 21 focused COCs or contain PTW-NAPL, the next successive 2-foot intervals (i.e., the two deepest remaining 1-foot intervals in the core that have not been sampled for DOC) will be pulled from archive and sampled. The process will be repeated until a RAL exceedance or PTW is encountered, at which point the DOC will be established with at least two successive 1-foot intervals below.

Based on a comprehensive review of core recoveries obtained for core lengths of 15 feet or greater within the Interim Project Area, NW Natural proposes a core recovery acceptability criterion of 70 percent. Each core will be visually logged for the presence of PTW-NAPL throughout the full penetration depth using the site-specific definition.

The data collection methods for the geotechnical data to be used in the dredge design evaluations is detailed in Section 3.2.3.2.

3.5 Dredge Material Handling, Transport, and Disposal Evaluation

Consistent with the Gasco Sediments Site SOW (EPA 2009) and Sections 4.4 and 4.5 of the TEWP, NW Natural will perform dredge material waste handling, transport, and disposal classification evaluations to pre-characterize the sediments that may potentially be dredged, transported, and disposed of off site. These evaluations will be informed by the collection of sediment cores throughout the Interim Project Area that will be subject to the testing described in the following sections. Sample collection methodologies and analytical testing are discussed in detail in the *Pre-Remedial Design Data Gaps Field Sampling Plan* (Appendix A) and *Pre-Remedial Design Data Gaps Quality Assurance Project Plan* (Appendix B).

3.5.1 Dredge Material Handling, Transport, and Disposal Evaluations Data Gaps Sampling Objectives and Sampling Design

The following subsections present the sampling objectives and sampling design for dredge sediment waste handling, transport, and disposal evaluations.

3.5.1.1 Dredge Material Handling and Transport Evaluation

Dredge material handling and transport evaluations are proposed via testing performed on 11 core locations shown on Figure 11. Each collected core will be tested for the following data objectives:

- Estimate the quality of dredge material haul barge dewatering fluids to determine what type of treatment or amendment may be necessary to manage these wastewater on the haul barges, at the offload facility, and at the landfill (if required).
- Estimate the most efficient type and amount of dredge material haul barge dewatering amendment necessary to meet federal, state, and local Applicable or Relevant and Appropriate Requirements and facility waste-acceptance requirements, and to facilitate truck or rail transport to the disposal facility.

Dredge Material Haul Barge Dewatering Testing. Gasco Sediment Site river water and bulk sediment representative of potential dredge materials will be collected to be used for the haul barge dewatering testing. This testing involves mixing the sediment and water in a specified ratio, followed by agitation of the slurry mixture for a specified period, settling or filtration of solids, and analysis of the resulting water column. Standard elutriate tests will be conducted in accordance with national dredged material disposal guidelines (EPA and USACE 1991). The quality of the dredge elutriate will then be compared to the appropriate water quality standards based on the selected elutriate management option.

For discharge of the dredge haul barge elutriate back to the Willamette River in the construction area, due to the short-term and intermittent nature of dredge dewatering elutriate discharges, and because construction activities will only be occurring during a portion of the day (i.e., non-24-hour work shifts), the appropriate standards for water quality evaluation are acute water quality criterion. NW Natural proposes analyzing the dredge dewatering elutriate samples for those chemicals containing ROD Table 17 surface water cleanup levels that have applicable acute water quality criteria or reliable acute ecological screening values for surface water, which include the following:

- Acute freshwater Criterion Maximum Concentration (CMC) identified in DEQ's Table 30: Aquatic Life Water Quality Criteria for Toxic Pollutants (Oregon Administrative Rule 340-041-8033)
- Acute freshwater CMC identified in EPA's *National Recommended Water Quality Criteria – Aquatic Life Criteria Table* (EPA 2019)
- Procedures for the Derivation of Equilibrium Partitioning Sediment Benchmarks (ESBs) for the Protection of Benthic Organisms: PAH Mixtures (EPA 2003) for PAHs because there are no DEQ and EPA acute CMC criteria for these chemicals
- The Oak Ridge National Laboratory Tier II secondary acute ecological screening values for surface water for those ROD Table 17 chemicals that do not have DEQ, EPA, or ESB values

Based on these water quality criteria and screening values, NW Natural will analyze the following chemical classes: metals, PCBs, pesticides, PAHs, semivolatile organic compounds, and VOCs. pH and total suspended solids analyses will also be analyzed. Dioxin/furan analyses will not be performed, given these chemicals do not have an applicable water quality criteria. Tributyl tin will not be analyzed because it is not a site-specific COC and project area sediments do not contain elevated surface or subsurface sediment concentrations. Results of the elutriate evaluations and associated recommendations for remedial design for managing haul barge elutriate during dredging will be presented in the Basis of Design Report.

Dredge Material Stabilization Testing. Dredge material stabilization tests will be performed using various pozzolanic materials (e.g., Portland cement, calciment, lime kiln dust) and material dosages to determine the appropriate amendment to cost-effectively stabilize dredge material so it meets the applicable transport and disposal facility material strength requirements. Stabilization will be performed using a variety of amendment types and dosages described in the *Pre-Remedial Design Data Gaps Field Sampling Plan* (Appendix A). Optimum dosage ratios will be evaluated through paint filter testing, percent solids analysis, and visual observations of physical characteristics at specified cure periods (e.g., 24 hours, 48 hours, and 72 hours). The goal is to determine the most optimum combination of amendment, dosage ratio, and cure time to allow the stabilized end product to pass the paint filter test and meet the minimum structural strength required by the disposal facility.

3.5.1.2 Dredge Material Disposal Suitability Testing

The Gasco Sediments Site SOW (EPA 2009) identifies that the sample density requirement for pre-construction waste disposal characterization as approximately one sample per 10,000 cubic yards of dredge material. The final dredge volume will be determined during remedial design using the multiple-LOE technical evaluations detailed in the TEWP, consistent with the ROD requirements. Therefore, for the purposes of this data gaps investigation, the average dredge volume for Alternative 4 from the Draft EE/CA (Anchor QEA 2012a) was used to conservatively estimate a potential upper-end range dredge volume of approximate 330,000 cubic yards of dredge material. This estimated dredge volume results in approximately 33 pre-construction sample locations for dredge material disposal suitability testing. Site-specific TCLP testing was performed by NW Natural in 2004 during the 2005 Removal Action design characterization (Anchor Environmental 2004), in 2009 as part of a focused TCLP investigation (Anchor QEA 2010c), and in 2010 during the Project Area Identification Report data gaps sampling (Anchor QEA 2010b). These previous sampling efforts resulted in the analysis of 23 TCLP samples within the Interim Project Area. Accounting for these data, NW Natural proposes additional dredge material disposal suitability testing at the 12 core locations shown on Figure 12. Each of these locations is co-located with a DOC core (see Section 3.4). These locations include a single sample in Area 2 shown on Figure 12 containing previously detected elevated transition zone water concentrations for chlorinated solvents that is sourced from historical Siltronic property releases.

A single composite sample from each core will be analyzed for the following:

- Resource Conservation and Recovery Act (RCRA) waste characteristics (ignitability and corrosivity)
- F002 wastes (TCE; cis-DCE; trans-DCE; 1,1-DCE; and vinyl chloride)
- TCLP analytes (RCRA eight metals, VOCs, semivolatile organic compounds, pesticides, and herbicides)

The RCRA waste characteristics will be defined based on 40 Code of Federal Regulations (CFR) 261.C. The TCLP elutriate concentrations will be compared against the TCLP criteria defined in 40 CFR 261.24. Potential F002 wastes will be compared against occupational risk-based concentrations (RBCs; from the May 2018 "Risk-Based Concentrations for Individual Chemicals" table [DEQ 2018]).

Initially, each composite sample will be analyzed for the above parameters without any dewatering amendment. If no RCRA waste characteristics are identified and there are no exceedances of the TCLP or F002-related occupational RBCs, no additional testing will be performed. Alternatively, for any unamended samples that contain RCRA waste characteristics or exceedances of the TCLP or F002-related occupational RBCs, the samples will be stabilized with dewatering amendments and retested (only for the applicable tests driving the amendment addition).

NW Natural has confirmed that there are no disposal facility requirements to test for the reactivity characteristic.[5] Instead, reactivity is designated based on generator knowledge. The eight criteria are listed below in **bold text** with the basis of NW Natural's knowledge in terms of each criteria in regular text.

1. **It is normally unstable and readily undergoes violent change without detonating.** The sediment is stable and would have violently changed by now if that was its inclination.
2. **It reacts violently with water.** The sediment is under water and would have reacted violently with water if that was its inclination.
3. **It forms potentially explosive mixtures with water.** See response to criterion 2.
4. **When mixed with water, it generates toxic gases, vapors or fumes in a quantity sufficient to present a danger to human health or the environment.** The sediment is currently mixed with water. Numerous sediment investigations at various depths nave been conducted in the Interim Project Area with air quality monitoring, and there has been no evidence of toxic gases, vapors, or fumes.
5. **It is a cyanide or sulfide bearing waste which, when exposed to pH conditions between 2 and 12.5, can generate toxic gases, vapors, or fumes in a quantity sufficient to present a danger to human health or the environment.** There have been numerous sediment investigations at various depths throughout the Interim Project Area with air quality monitoring, and there has been no indication that toxic gases, vapors, or fumes have been generated.
6. **It is capable of detonation or explosive reaction if it is subjected to a strong initiating source or if heated under confinement.** The sediment is not an explosive material and, to the best of NW Natural's knowledge, does not contain residues of explosives.
7. **It is readily capable of detonation or explosive decomposition or reaction at standard temperature and pressure.** See response to criterion 6.
8. **It is a forbidden explosive as defined in 49 CFR 173.54, or is a Division 1.1, 1.2, or 1.3 explosive as defined in 49 CFR 173.50 and 173.53.** See response to criterion 6.

3.5.1.3 Riverbank Material Disposal Suitability Testing

NW Natural previously performed riverbank material disposal suitability testing at a single top of riverbank boring location in October 2010, and the results are reported in the Draft EE/CA (Anchor QEA 2012a). A composite sample was preferentially collected from the 16.5- to 18.5-foot depth interval that contained visual signs of contamination. The boring location is shown on Figure 12. Accounting for this previous location, NW Natural proposes additional dredge material disposal suitability testing on the Gasco property at the four boring locations shown on Figure 12. A single composite sample will be collected and analyzed for the RCRA waste characteristics and TCLP

[5] There are no current test procedures for the reactivity characteristic. There were some reactivity tests that were used historically, but those test methods were withdrawn over 20 years ago.

analytes identified in Section 3.5.1.2. The RCRA waste characteristics definitions and TCLP criteria will be consistent with Section 3.5.1.2.

Riverbank disposal suitability testing will also be performed on two samples collected on the Siltronic property (Figure 12) using consistent sampling methods and chemical analyses proposed on the Gasco property, with the exception that the samples will also be analyzed for F002 wastes (TCE; cis-DCE; trans-DCE; 1,1-DCE; and vinyl chloride). The RCRA waste characteristics definitions, TCLP criteria, and F002 occupational RBCs will be consistent with Section 3.5.1.2.

For the samples collected on both the Gasco and Siltronic properties, consistent with Section 3.5.1.2, initially each composite sample will be analyzed for the above parameters without any dewatering amendment. If no RCRA waste characteristics are identified and there are no exceedances of the TCLP or F002-related occupational RBCs, no additional testing will be performed. Alternatively, for any unamended samples that contain RCRA waste characteristics or exceedances of the TCLP or F002-related occupational RBCs, the samples will be stabilized with dewatering amendments and retested (only for the applicable tests driving the amendment addition).

3.5.2 Dredge Material Handling, Transport, and Disposal Evaluations Data Collection Methods

The following subsections present the data collection methods for the dredge material handling, transport, and waste disposal evaluations.

3.5.2.1 Dredge Material Waste Handling and Transport

At each of the proposed 12 locations, one vertically composited sample interval will be collected from the existing surface to the DOC (or bottom of the core if DOC is unbounded), which will be estimated in the field based on visual and olfactory indications of contamination. While this method to determine DOC is not guaranteed to capture the full depth of RAL or PTW threshold exceedances, it is considered sufficient for pre-construction characterization because NW Natural is required to field-verify waste disposal characterizations using the tiered barge sampling program presented in the SOW. A second co-located 20-foot vibracore will be advanced to provide sufficient volume for the proposed dredge material waste handling and transport analyses.

3.5.2.2 Dredge Material Disposal Suitability Testing

Sediment sampling will be performed at each of the proposed 12 locations identically to the sampling described in Section 3.5.2.1 (i.e., full-length composite sample taken from a second 20-foot core barrel co-located with DOC cores). Additional sampling method details are described in detail in the *Pre-Remedial Design Data Gaps Field Sampling Plan* (Appendix A).

3.5.2.3 Riverbank Material Disposal Suitability Testing

At six riverbank boring locations (4 on the Gasco property and 2 on the Siltronic property), one vertically composited sample interval will be collected from the existing surface to the DOC (or bottom of boring if DOC is unbounded). The DOC will be estimated in the field based on visual and olfactory indications of contamination. The samples will be taken directly from the angled riverbank borings discussed in Section 3.3. Additional sampling method details are described in detail in the *Pre-Remedial Design Data Gaps Field Sampling Plan* (Appendix A).

3.6 Additional Analyses

During meetings with EPA discussing the TEWP and the proposed data gaps sampling and analysis approach at the Gasco Sediments Site, EPA indicated that although manufactured gas plant (MGP)-related contaminants may have the largest lateral and vertical extents of contamination exceeding the applicable threshold and drive remedial design evaluations, EPA requested that some percentage of the total data gaps sampling density also include characterization for non-MGP-related contaminants[6] (e.g., PCBs, pesticides, and dioxin/furans) to document the unacceptable risks caused in the Interim Project Area. The remainder of this sections summarizes NW Natural's proposal to achieve this request.

3.6.1 Additional Analyses Data Quality Objectives and Sampling Design

While a subset of sampling data objectives (e.g., DOC coring) require the full suite of Portland Harbor Superfund Site RAL and PTW threshold COCs identified in ROD Table 21, other data objectives only require analysis of COCs that have been shown to likely govern remedial design (i.e., PAHs, VOCs, and arsenic for chemical isolation modeling, as discussed in Appendix D of the TEWP). This difference in analyte lists would lead to limited characterization for non-MGP-related contaminants (e.g., PCBs, pesticides, and dioxin/furans) during performance of the data gaps sampling. However, to provide EPA with a more robust dataset for the complete ROD Table 21 analyte list, NW Natural proposes the collection of the additional analytes for certain samples described in Section 3.6.2.

In addition, to more comprehensively characterize the chemical composition of the PTW-NAPL-impacted sediments at the Gasco Sediments Site, archived sediment core samples or pure NAPL samples recovered from shake tests (described in Section 3.2.2.1.1) will be selected for comprehensive hydrocarbon analysis.

Figure 13 shows the proposed sample locations for the additional analyses within the Interim Project Area. Sediment samples will be collected from all cores collected outside the navigation channel from the upper four capping demonstration core intervals (0 to 2 feet, 2 to 5 feet, 5 to 7 feet, and 7 to 10 feet in the shallow region transect, and 0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet in

[6] The non-site-specific categorization is based on historical and current operations.

the intermediate region transect [see Section 3.2.1.1.1]). These samples will be submitted for analysis of PCBs, DDx isomers, and PCDD/F congeners. These results, in conjunction with the PAH results obtained from the capping demonstration evaluations (see Section 3.2.1), will provide concentration for the full suite of ROD Table 21 COCs. Note that the in-channel surface grabs (Section 3.1.2) are already proposed for collection of the full suite of ROD Table 21 chemicals, so no additional analysis of those samples is proposed here.

3.6.2 Additional Analyses Data Collection Methods

The additional sample intervals and analytes proposed in Section 3.6.1 will be subsampled from the proposed DOC cores (see Section 3.4) and shake tests (see Section 3.2.2.1.1) using the same methodologies. No additional cores will be collected for these analyses.

As noted in Section 3.4.2, DOC cores will be split in half, and sediments from the half cores will be archived frozen in 1-foot intervals. Core log and other field observations of PTW-NAPL will be used to identify specific archived intervals as being highly impacted by NAPL. As noted in Section 3.2.2.1.1, visible NAPL produced in shake tests will be collected and subjected to analysis of NAPL physical characteristics. Between 4 and 12 archived core sediment samples containing visual observations of PTW-NAPL or other potential PAH-impacted material and/or NAPL samples produced in shake tests will be selected for comprehensive hydrocarbon analysis, and potentially also for stable isotope analysis and bulk element analysis (NAPL only) to better characterize the hydrocarbon residuals in the Interim Project Area. These data will be collected to assist in source identification.

4 Reporting

Following the completion of the data gaps investigation and analysis of data, NW Natural will develop and submit for EPA approval a *Pre-Remedial Design Data Gaps Sampling and Analysis Report*. The information from the *Pre-Remedial Design Data Gaps Sampling and Analysis Report* will be used to complete the technical evaluations described in the TEWP and develop the *Pre-Remedial Basis of Design Report*.

4.1 Report Contents

The *Pre-Remedial Design Data Gaps Sampling and Analysis Report* will include the following:

- Short narrative outlining any deviations from this Work Plan
- Actual sample coordinates for all sampling stations
- Updated sampling location figures
- Tabulated final validated data for all analytical tests performed
- Field forms including a daily form, a health and safety form, and all collection and processing logs
- Laboratory Data Reports
- Data Validation Reports

4.2 Reporting Schedule

The *Pre-Remedial Design Data Gaps Sampling and Analysis Report* is due to EPA for review within 75 days of receipt of validated data from the data gaps sampling. The *Pre-Remedial Basis of Design Report* is due to EPA for review within 120 days after receipt of validated data from the data gaps sampling.

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Tables

Table 1
Summary of Data Gaps Evaluations and Sampling Media

Technical Evaluation	Section in the Technical Evaluations Work Plan	Section in the Data Gaps Work Plan	Field Sampling and Analysis Required (Yes/No)	Sampling Media
1. Final Project Area Refinement	3	3.1	Yes	Surface grabs; subsurface sediment cores
2. Capping Demonstration - Element 1 (Contaminant Confinement)	4.1.3	3.2.1 and 3.2.2	Yes	Subsurface sediment cores; subsurface porewater samples; ebullition visual monitoring; sheen sampling
3. Capping Demonstration - Element 2 (Flood Flow Impacts)	4.1.4	2.1.1	No	NA
4. Capping Demonstration - Element 3 (Erosion Resistance)	4.1.5	2.1.2	No	NA
5. Capping Demonstration - Element 4 (Presence and Effect of Debris)	4.1.6	2.1.3 and 2.5	No	NA
6. Capping Demonstration - Element 5 (Slope Stability)	4.1.7	3.2.3	Yes	Sonic cores and CPT
7. Capping Demonstration - Element 6 (Bearing Capacity)	4.1.8	3.2.3	Yes	Sonic cores and CPT
8. Capping Demonstration - Element 7 (Treatment Requirements)	4.1.9	2.1.4	Yes	Subsurface sediment cores; subsurface porewater samples; ebullition visual monitoring; sheen sampling
9. Capping Demonstration - Element 10 (Department of State Lands Authorization Requirements)	4.1.11	2.1.5	No	NA
10. Dredging	4.2	3.4 and 3.2.3	Yes	Subsurface sediment cores; sonic cores and CPT
11. Riverbank Remedy	4.3	3.3	Yes	Angled sonic cores
12. Dredge Sediment Waste Handling and Transport	4.4	3.5	Yes	Subsurface sediment cores
13. Waste Disposal Classification	4.5	3.5	Yes	Subsurface sediment cores
14. Functional Structures Determination	4.6	2.2	No	NA
15. Water Quality Best Management Practices	4.7	2.3	Yes	Sonic cores and CPT
16. Flooding Impact	4.9	2.4	No	NA

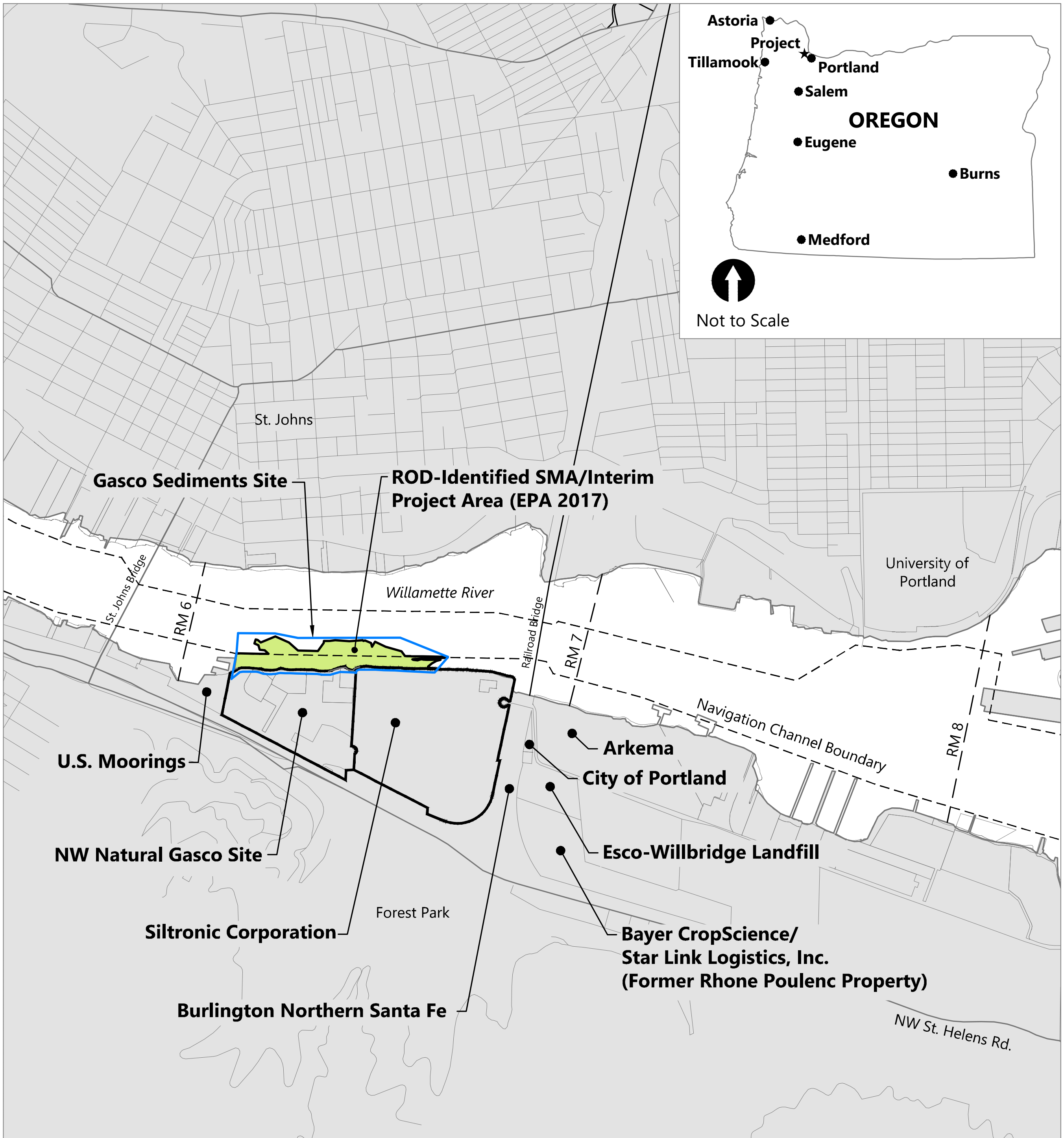
Notes:
CPT: cone penetration test
NA: not applicable

Table 2
Summary of Geotechnical Data Elements

Geotechnical Data Element	Data Use		
	Stability	Bearing Capacity	Consolidation
Moisture Content	●	●	●
Atterberg Limits	●	●	●
Grain Size	●	●	●
Specific Gravity	●	●	●
Dry Bulk Density	●	●	●
One-dimensional Consolidation			●
Direct Shear Strength	●	●	
Triaxial Shear Strength	●	●	
SPT Blow Counts	●	●	●
CPT Records	●	●	●

Notes:
CPT: cone penetration test
SPT: standard penetration test

Figures



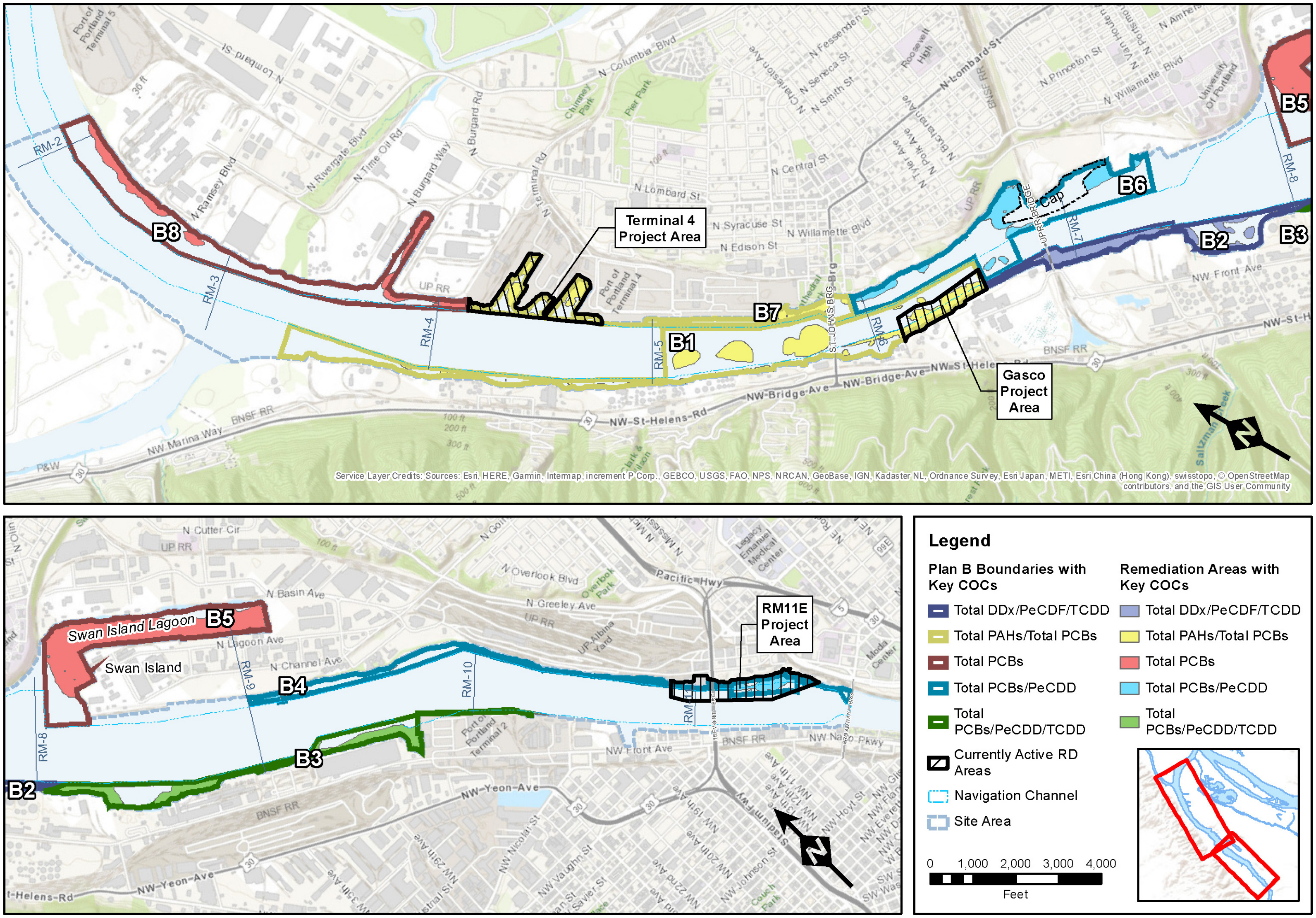
HORIZONTAL DATUM: Oregon State Plane North, North American Datum (NAD83/HARN 91), International Feet.

NOTE: All locations are approximate.

Publish Date: 2019/08/21 7:54 AM | User: hmerrick
Filepath: K:\Projects\0029-NW Natural Gas Co\Gasco Sediments_Pre-Remedial Design\Pre_RD Data Gaps SAP\0029-RP-002 (Vicinity Map).dwg Figure 1 WP

Figure 1
Vicinity Map

Revised Pre-Remedial Design Data Gaps Work Plan
Gasco Sediments Cleanup Action



Project Areas

Portland Harbor Superfund Site

EPA document dated March 7, 2019

Filepath: \\orcas\GIS\Jobs\NW_Natural_Gas_0029\Gasco_Sediments\Maps\Reports\DataGapsWorkPlan2018\AQ_DGWP_Fig02_EPAProjectAreas.docx

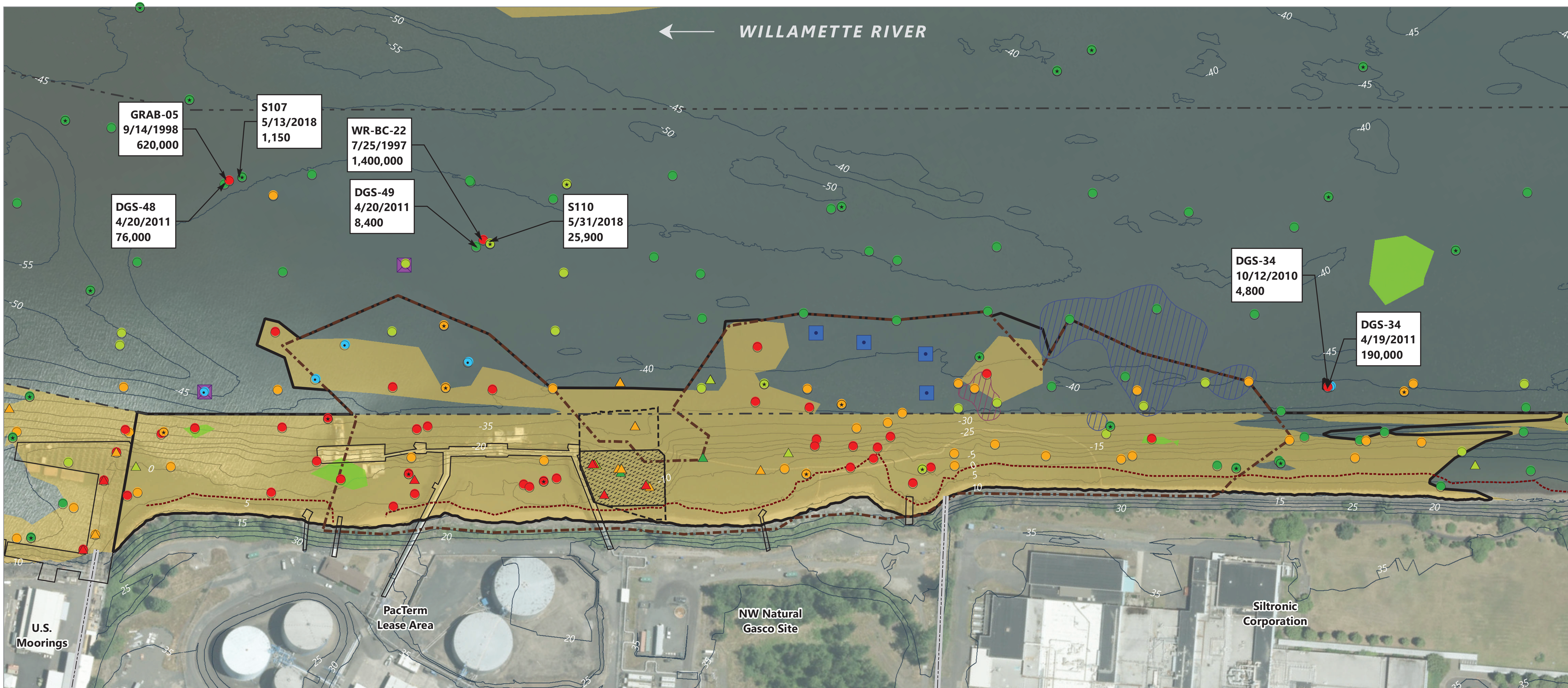
ANCHOR QEA

Figure 2

EPA-Identified Gasco Project Area

Revised Pre-Remedial Design Data Gaps Work Plan

Gasco Sediments Cleanup Action



LEGEND:

- Navigation Channel
- Structures
- Property Line
- Tar Body Removal Action Area (RAPP, Anchor 2005)
- Tar Body Removal Action Pilot Cap
- PTW-NAPL Boundary
- Elevation (feet COP)
- Approximate Riprap Boundary[1]
- ROD-Identified SMAs (EPA 2017) Included in the Ga sco Sedim ent Site Interim Project Area[2]
- Total Area Exceeding ROD Table 21 Focused COC RALs and PTW-Highly Toxic Additional Contaminant Thresholds[4]
- Total PCB PTW-Highly Toxic Additional Contaminant Threshold Exceedance
- 2010 Transition Zone Water Vinyl Chloride Area 1 Boundary (Anchor QEA 2012)[5]
- Area 2 – Detected CVOCs in TZW and One Subsurface Sediment Location[6]

Total PAH (μg/kg)

- ≤ ROD RAL (13,000)
- > ROD RAL (13,000) and ≤ ROD RAL ESD (30,000)
- > ROD RAL ESD (30,000) and ≤ Nav ROD RAL (170,000)
- > Nav ROD RAL (170,000)

- Pre-RD Group Harborwide Monitoring Surface Sample Location (AECOM and Geosyntec 2018a)
- Surface Sample Locations Not Included in the ROD
- Surface Sample Location Included in the ROD
- Proposed Interim Project Area Verification Surface Sediment Grab
- Proposed 0- to 1-Foot Interval For Additional Surface Sediment Concentration Data Density
- Proposed 1-2 ft, 2-3 ft, and 3-4 ft Interim Project Area Refinement Subsurface Sample Locations

NOTES:

1. Estimated from side scan sonar survey conducted by Blue Water Engineering April 2011.
2. All depicted SMA technology and PTW contours taken from the Portland Harbor Superfund Site Record of Decision (2017) without application of the EPA Explanation of Significant Differences (ESD; EPA 2018), which is not yet finalized.
3. Total area determined based on exceedances of ROD Table 21 focused COC RALs and PTW-highly toxic additional contaminant thresholds. Does not account for ESD, which is still undergoing public review and comment.
4. Boundary taken from Draft Engineering Evaluation/Cost Analysis, Appendix A, Figure 4.2. Transition zone water screening level exceedances of cis-1,2-dichloroethene identified within this vinyl chloride boundary.
5. Boundary taken from Gasco Sediments Site Statement of Work, Figure 1 (EPA 2009).
6. Bathymetry surveyed by DEA 2018. Topography surveyed by Geometrix 2011.
7. Arrow indicates direction of flow of river.
8. Horizontal datum is NAD83 (HARN 91) Oregon State Plane North, International Feet.
9. Vertical datum is City of Portland (COP), Feet.
10. Aerial imagery from City of Portland 2016.

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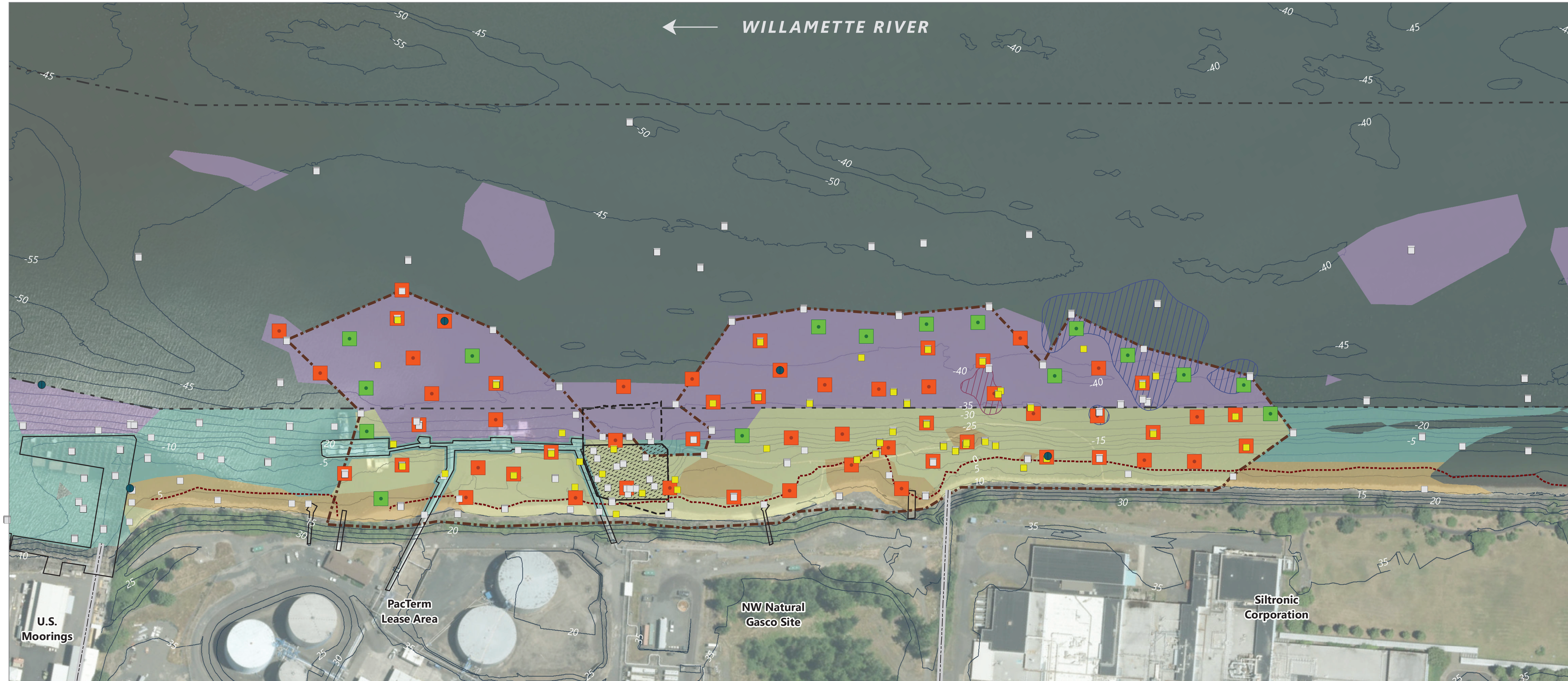
Figure 3
Proposed Interim Project Area Refinement Sampling Locations



LEGEND:

- Navigation Channel
- Structures
- Property Line
- Tar Body Removal Action Area (RAPP, Anchor 2005)
- Tar Body Removal Action Pilot Cap
- PTW-NAPL Boundary
- Elevation (feet COP)
- Approximate Riprap Boundary[1]

ROD SMA Technology[2]

- Cap
- Dredge
- Dredge in Nav-FMD
- Dredge with Cap
- 2010 Transition Zone Water Vinyl Chloride Area 1 Boundary (Anchor QEA 2012)[3]
- Area 2 – Detected CVOCs in TZW and One Subsurface Sediment Location[4]

- Pre-RD Group Harborwide Monitoring Subsurface Sample Location (AECOM and Geosyntec 2018a)
- Existing Cores with Previously Observed PTW-NAPL
- Existing Subsurface Sample Location
- Proposed DOC Core[5]
- Proposed DOC and PTW-NAPL Refinement Core

NOTES:

1. Estimated from side scan sonar survey conducted by Blue Water Engineering April 2011.
2. All depicted SMA technology and PTW contours taken from the Portland Harbor Superfund Site Record of Decision (2017) without application of the EPA Explanation of Significant Differences (ESD; EPA 2018), which is not yet finalized.
3. Boundary taken from Draft Engineering Evaluation/Cost Analysis, Appendix A, Figure 4.2. Transition zone water screening level exceedances of cis-1,2-dichloroethene identified within this vinyl chloride boundary.
4. Boundary taken from Gasco Sediments Site Statement of Work, Figure 1 (EPA 2009).
5. The nearshore core locations may need to be adjusted further offshore depending on the river elevations during sample collection to facilitate vessel access.
6. Bathymetry surveyed by DEA 2018. Topography surveyed by Geometrix 2011.
7. Arrow indicates direction of flow of river.
8. Horizontal datum is NAD83 (HARN 91) Oregon State Plane North, International Feet.
9. Vertical datum is City of Portland (COP), Feet.
10. Aerial imagery from City of Portland 2016.

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Figure 4
Proposed Subsurface Depth of Contamination and PTW-NAPL Boundary Refinement Cores

Revised Pre-Remedial Design Data Gaps Work Plan
Gasco Sediments Cleanup Action

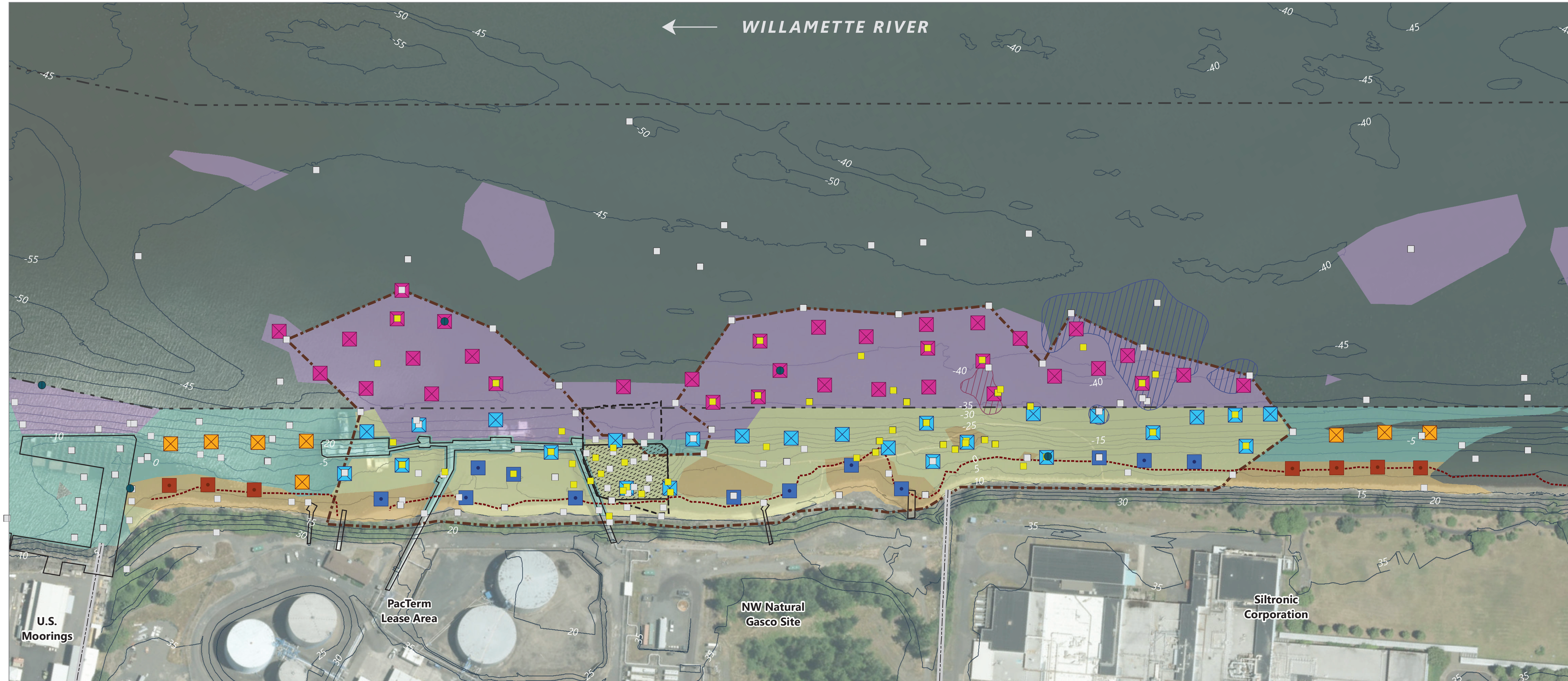
Habitat Layer	Material type and thickness to be determined during remedial design in coordination with EPA and resource agency. No data gaps identified.
Erosion Resistance Layer	The need for an erosion resistance layer and design, if necessary, will be evaluated during a desktop review of data sources described in Section 2.1.2 of the Pre-Remedial Design Data Gaps Work Plan. No data gaps identified.
Geotechnical Filter Layer	If a filter layer is necessary to prevent fine-grained chemical isolation layer materials from migrating upward through pore spaces in the coarse-grained erosion resistance layer, the gradation of the chemical isolation materials and erosion resistance layer materials will be used to design the filter layer. No data gaps identified.
Chemical Isolation Layer	Material type and thickness to be determined based on measured groundwater flows and porewater chemical concentrations converted from bulk sediment chemical concentrations using site-specific and literature equilibrium partitioning coefficients. Data gaps are identified in Section 3.2.1 of the Pre-Remedial Design Data Gaps Work Plan.
PTW Reactive Layer	Material type and thickness will be determined based on calculated PTW-NAPL mass loading by advection, ebullition-facilitation PTW-NAPL transport, and PTW-NAPL transport from sediment consolidation following cap placement. Data gaps are identified in Section 3.2.2 of the Pre-Remedial Design Data Gaps Work Plan.
Underlying Sediment	Sediment geotechnical parameters will be used to design caps and inform cap placement requirements to account for slope stability and bearing capacity concerns and post-placement consolidation. Data gaps are identified in Section 3.2.3 of the Pre-Remedial Design Data Gaps Work Plan.

NOTE

1. Layers of this conceptual cap cross section are not drawn to scale and will be determined during technical evaluations and remedial design.

Figure 5

Capping Demonstration – Conceptual Isolation Cap Cross Section with Design Evaluation Data Uses



LEGEND:

- Navigation Channel
- Structures
- Property Line
- Tar Body Removal Action Area (RAPP, Anchor 2005)
- Tar Body Removal Action Pilot Cap
- PTW-NAPL Boundary
- Elevation (feet COP)
- Approximate Riprap Boundary[1]

ROD SMA Technology[2]

- Cap
- Dredge
- Dredge in Nav-FMD
- Dredge with Cap
- 2010 Transition Zone Water Vinyl Chloride Area 1 Boundary (Anchor QEA 2012)[3]
- Area 2 – Detected CVOCs in TZW and One Subsurface Sediment Location[4]

- Pre-RD Group Harborwide Monitoring Subsurface Sample Location (AECOM and Geosyntec 2018a)
- Existing Cores with Previously Observed PTW-NAPL
- Existing Subsurface Sample Location

Proposed Capping Only Cores

- Consecutive 2-ft Intervals Throughout Core Penetration Depth
- 0-2 ft, 2-5 ft, 5-7 ft, 7-10 ft, and 10-13 ft Intervals[5,6]

Proposed Dredge and Cap Cores[7]

- Consecutive 2-ft Intervals Throughout Core Penetration Depth
- 0-2 ft, 2-5 ft, 5-7 ft, 7-10 ft, and 10-13 ft Intervals[5,6]
- Consecutive 2-ft Intervals Throughout Core Penetration Depth Initiating at -47 Feet COP Elevation[8]

NOTES:

1. Estimated from side scan sonar survey conducted by Blue Water Engineering April 2011.
2. All depicted SMA technology and PTW contours taken from the Portland Harbor Superfund Site Record of Decision (2017) without application of the EPA Explanation of Significant Differences (ESD; EPA 2018), which is not yet finalized.
3. Boundary taken from Draft Engineering Evaluation/Cost Analysis, Appendix A, Figure 4.2. Transition zone water screening level exceedances of cis-1,2-dichloroethene identified within this vinyl chloride boundary.
4. Boundary taken from Gasco Sediments Site Statement of Work, Figure 1 (EPA 2009).
5. Potentially deeper samples will be collected if PTW-NAPL is identified. NAPL mobility testing may be conducted based on PTW-NAPL observations in deeper intervals.
6. The nearshore core locations may need to be adjusted further offshore depending on the river elevations during sample collection to facilitate vessel access.
7. All dredge and cap core locations are identical to DOC locations shown in Figure 5.
8. Capping in the channel becomes feasible in the navigation channel below -47 feet COP, based on ROD-identified -43 feet Columbia River Datum (CRD) authorized federal maintenance dredging elevation plus 3 feet overdredge plus 4- to 5-foot underlying cap thickness plus conversion from CRD to COP datum.
9. Bathymetry surveyed by DEA 2018. Topography surveyed by Geometrix 2011.
10. Arrow indicates direction of flow of river.
11. Horizontal datum is NAD83 (HARN 91) Oregon State Plane North, International Feet.
12. Vertical datum is City of Portland (COP), Feet.
13. Aerial imagery from City of Portland 2016.

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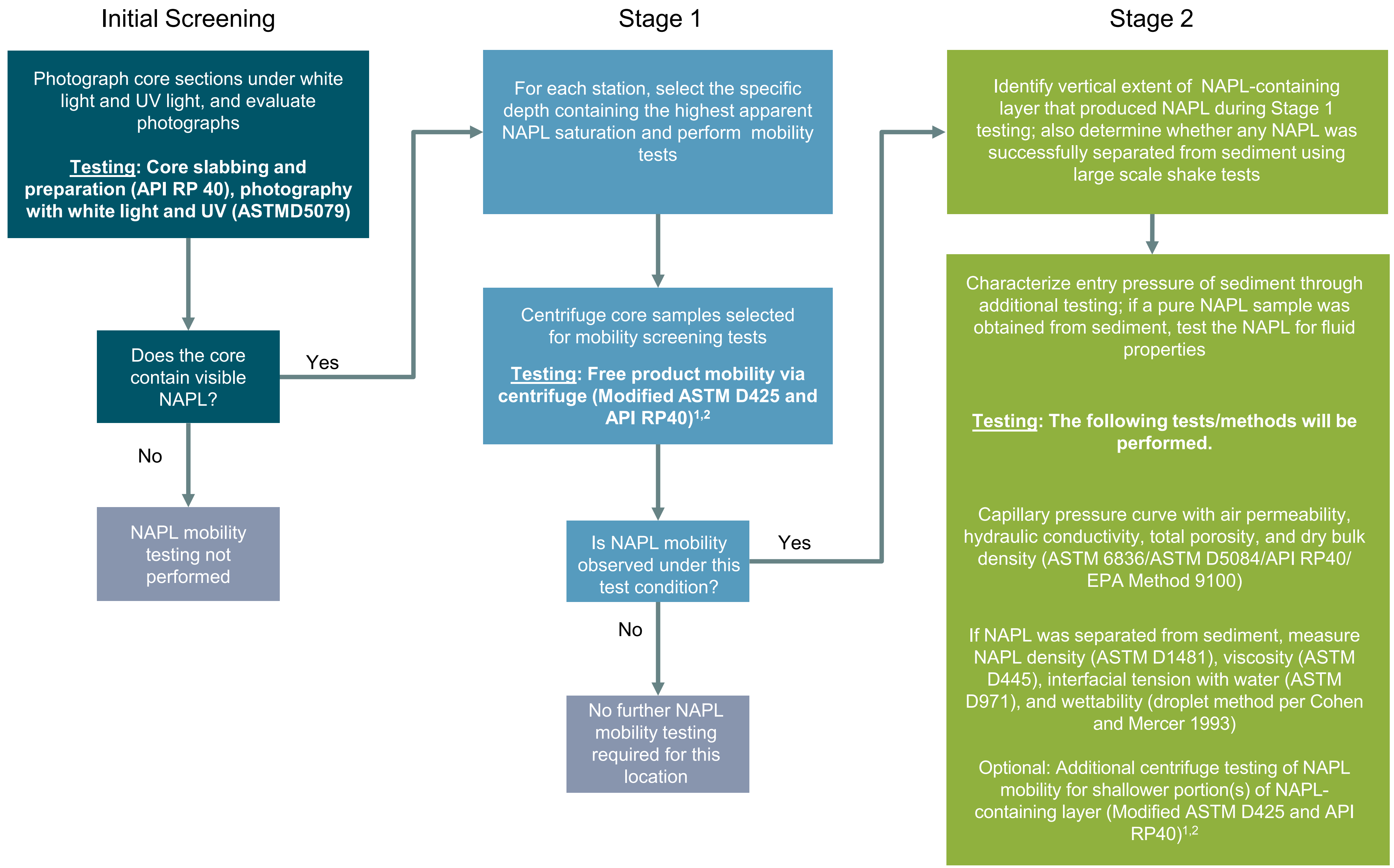
ANCHOR QEA

Figure 6
Proposed Subsurface Capping Demonstration Cores
Revised Pre-Remedial Design Data Gaps Work Plan
Gasco Sediments Cleanup Action



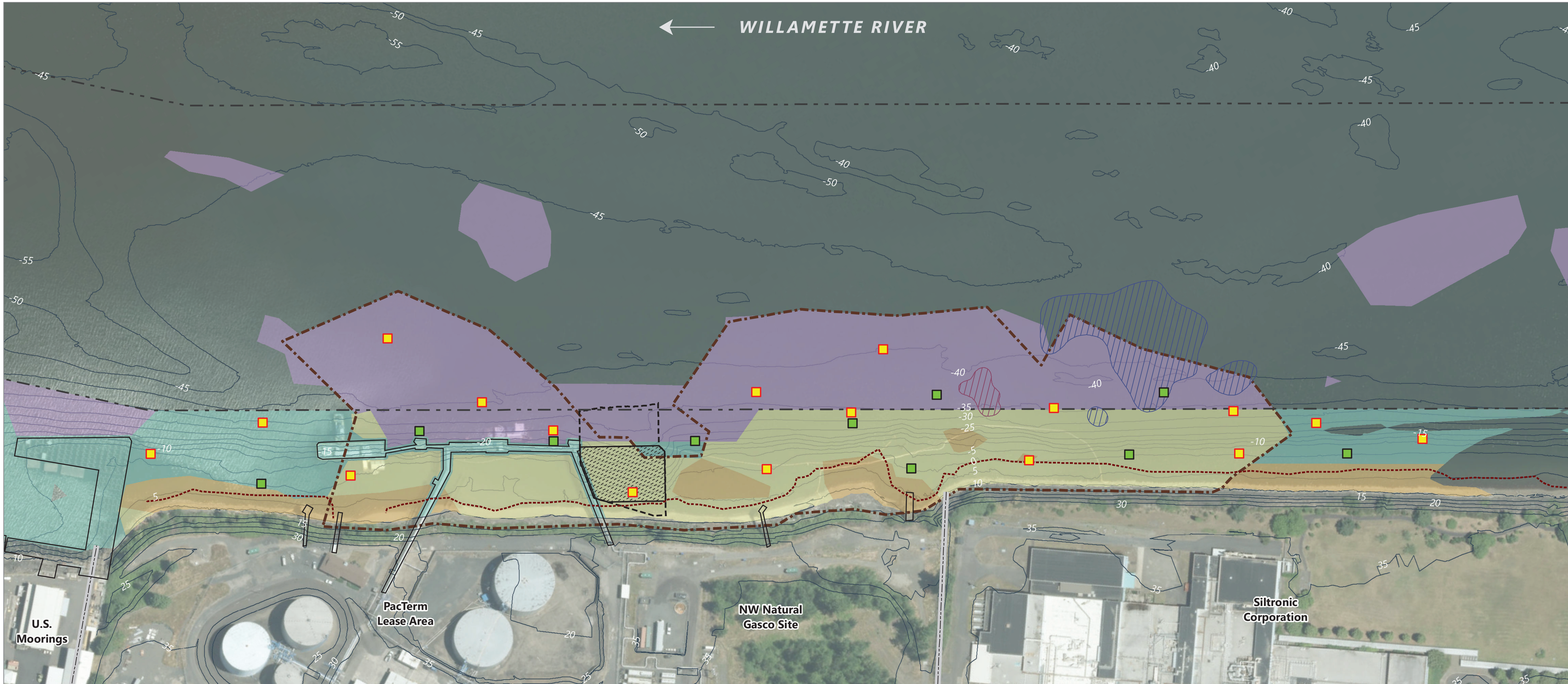
Notes:

1 = Centrifuging of selected core samples will be performed at a spin rate equal to 25 times the force of gravity for 10 hours. Any sample that does not show NAPL mobility under this test condition indicates negligible NAPL hydraulic conductivity, on the order of 10^{-9} centimeters per second or less.

2 = In addition to mobility testing, measurements will include initial and final pore fluid saturations, total porosity, specific gravity, and dry bulk density by API RP40.

ANCHOR QEA

Figure 7
NAPL Mobility Testing Approach
Revised Pre-Remedial Design Data Gaps Work Plan
Gasco Sediments Cleanup Action



LEGEND:

- Navigation Channel
- Structures
- Property Line
- Tar Body Removal Action Area (RAPP, Anchor 2005)
- Tar Body Removal Action Pilot Cap
- PTW-NAPL Boundary
- Elevation (feet COP)
- Approximate Riprap Boundary[1]

ROD SMA Technology[2]

- Cap
- Dredge
- Dredge in Nav-FMD
- Dredge with Cap
- 2010 Transition Zone Water Vinyl Chloride Area 1 Boundary (Anchor QEA 2012)[3]
- Area 2 – Detected CVOCs in TZW and One Subsurface Sediment Location[4]

- Proposed Sonic Core with Standard Penetration Test[5]
- Proposed In Situ Penetration Test[5]

NOTES:

1. Estimated from side scan sonar survey conducted by Blue Water Engineering April 2011.
2. All depicted SMA technology and PTW contours taken from the Portland Harbor Superfund Site Record of Decision (2017) without application of the EPA Explanation of Significant Differences (ESD; EPA 2018), which is not yet finalized.
3. Boundary taken from Draft Engineering Evaluation/Cost Analysis, Appendix A, Figure 4.2. Transition zone water screening level exceedances of cis-1,2-dichloroethene identified within this vinyl chloride boundary.
4. Boundary taken from Gasco Sediments Site Statement of Work, Figure 1 (EPA 2009).
5. The nearshore locations may be adjusted further toward of riverbank depending on the river elevations during sample collection if vessel access allows.
6. Bathymetry surveyed by DEA 2018. Topography surveyed by Geometrix 2011.
7. Arrow indicates direction of flow of river.
8. Horizontal datum is NAD83 (HARN 91) Oregon State Plane North, International Feet.
9. Vertical datum is City of Portland (COP), Feet.
10. Aerial imagery from City of Portland 2016.

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Figure 8
Proposed Geotechnical Explorations
Revised Pre-Remedial Design Data Gaps Work Plan
Gasco Sediments Cleanup Action

LEGEND:

- Navigation Channel
- Structures
- Property Line
- Tar Body Removal Action Area (RAPP, Anchor 2005)
- Tar Body Removal Action Pilot Cap
- PTW-NAPL Boundary
- Elevation (feet COP)
- Approximate Riprap Boundary[1]

ROD SMA Technology[2]

- Cap
- Dredge
- Dredge in Nav-FMD
- Dredge with Cap
- 2010 Transition Zone Water Vinyl Chloride Area 1 Boundary (Anchor QEA 2012)[3]
- Area 2 – Detected CVOCs in TZW and One Subsurface Sediment Location[4]

- Extent of DNAPL Deemed Potentially Mobile Identified in Interim Feasibility Study (Anchor QEA 2018b; 0 to 12 feet)
- Extent of DNAPL Deemed Potentially Mobile Identified in Interim Feasibility Study (Anchor QEA 2018b; 12 to 22 feet)
- Existing Cores with Previously Observed PTW-NAPL
- Existing Subsurface Sample Location
- Soil Boring
- Top of Riverbank Borings[5]
- Proposed Angled Top of Riverbank Boring[6]
- Extent of Armored Siltronic Riverbank

NOTES:

1. Estimated from side scan sonar survey conducted by Blue Water Engineering April 2011.
2. All depicted SMA technology and PTW contours taken from the Portland Harbor Superfund Site Record of Decision (2017) without application of the EPA Explanation of Significant Differences (ESD; EPA 2018), which is not yet finalized.
3. Boundary taken from Draft Engineering Evaluation/Cost Analysis, Appendix A, Figure 4.2. Transition zone water screening level exceedances of cis-1,2-dichloroethene identified within this vinyl chloride boundary.
4. Boundary taken from Gasco Sediments Site Statement of Work, Figure 1 (EPA 2009).
5. Top of riverbank borings collected in 2009 to support sediment remedy evaluation of subsurface soil concentrations and disposal suitability.
6. The locations may need to be adjusted in the field as necessary to facilitate equipment access.
7. Arrow indicates direction of flow of river.
8. Horizontal datum is NAD83 (HARN 91) Oregon State Plane North, International Feet.
9. Vertical datum is City of Portland (COP), Feet.
10. Aerial imagery from City of Portland 2016.

6. Bathymetry surveyed by DEA 2018. Topography surveyed by Geometrix 2011.

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Feet

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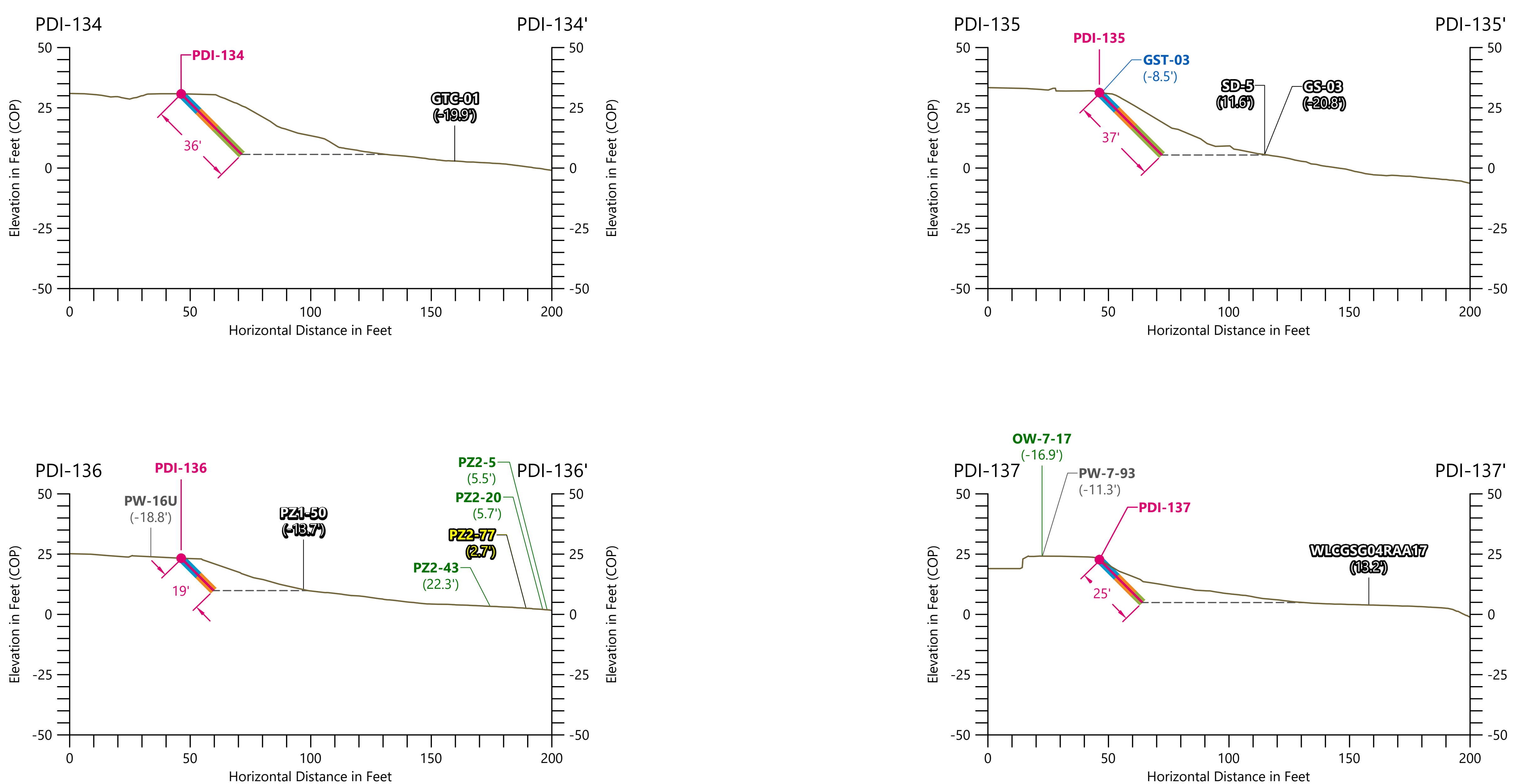
Figure 9
Proposed Angled Top of Riverbank Borings
Revised Pre-Remedial Design Data Gaps Work Plan
Gasco Sediments Cleanup Action



LEGEND:

- Proposed Riverbank Core
- XX Existing Sediment/Riverbank Sample Location
- XX Existing Groundwater Monitoring Sample Location
- XX Existing Upland Sample Location
- XX Existing Core with Previously Observed PTW-NAPL
- XX Existing Core without Previously Observed PTW-NAPL
- (X.X') Offset Distance in Feet
- 0'-10' Sample Interval
- 10'-20' Sample Interval
- 20'-Bottom of Core Sample Interval

0 50
Feet

HORIZONTAL DATUM: Oregon State Plane North, North American Datum of 1983 (NAD83/HARN 91), International Feet
VERTICAL DATUM: City of Portland (COP)
NOTE: Sampling will be performed at 0-10 feet, 10-20 feet, and 20 feet to remainder of length shown in each section above on a vertical basis. Actual sample lengths collected from each boring will be longer as a result of the boring being driven at an angle.

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Filepath: K:\Projects\0029-NW Natural Gas Co\Gasco Sediments_Pre-Remedial Design\Pre_RD Data Gaps SAP\0029-RP-004 (Sections).dwg Figure 10a

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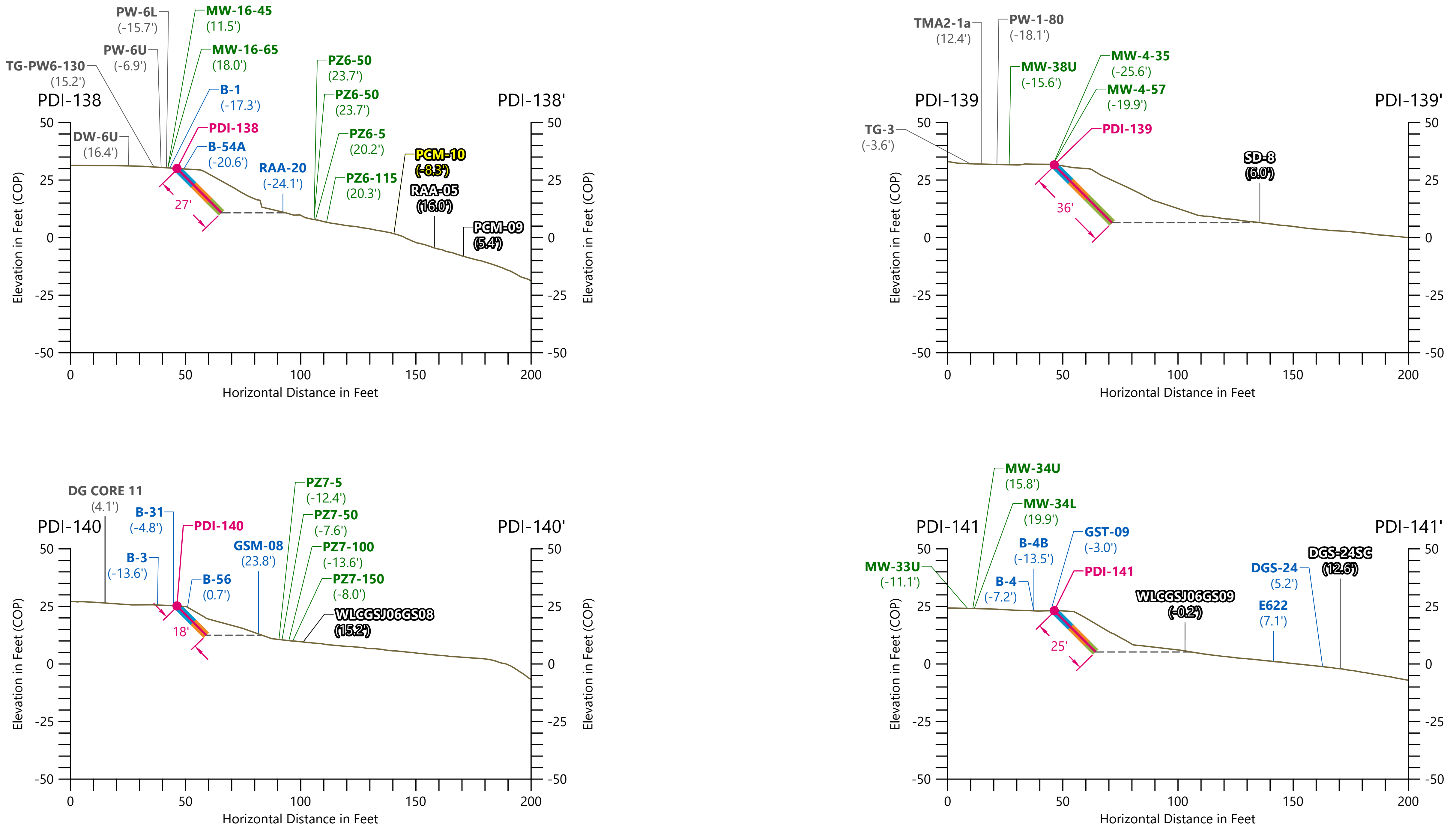
Figure 10a
Proposed Angled Top of Riverbank Borings – Riverbank Borings PDI-134 - PDI-137



LEGEND:

- Proposed Riverbank Core
- XX Existing Sediment/Riverbank Sample Location
- XX Existing Groundwater Monitoring Sample Location
- XX Existing Upland Sample Location
- XX Existing Core with Previously Observed PTW-NAPL
- XX Existing Core without Previously Observed PTW-NAPL
- (X.X') Offset Distance in Feet
- 0'-10' Sample Interval
- 10'-20' Sample Interval
- 20'-Bottom of Core Sample Interval

0 50
Feet

HORIZONTAL DATUM: Oregon State Plane North, North American Datum of 1983 (NAD83/HARN 91), International Feet
VERTICAL DATUM: City of Portland (COP)
NOTE: Sampling will be performed at 0-10 feet, 10-20 feet, and 20 feet to remainder of length shown in each section above on a vertical basis. Actual sample lengths collected from each boring will be longer as a result of the boring being driven at an angle.

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Filepath: K:\Projects\0029-NW Natural Gas Co\Gasco Sediments_Pre-Remedial Design\Pre_RD Data Gaps SAP\0029-RP-004 (Sections).dwg Figure 10b

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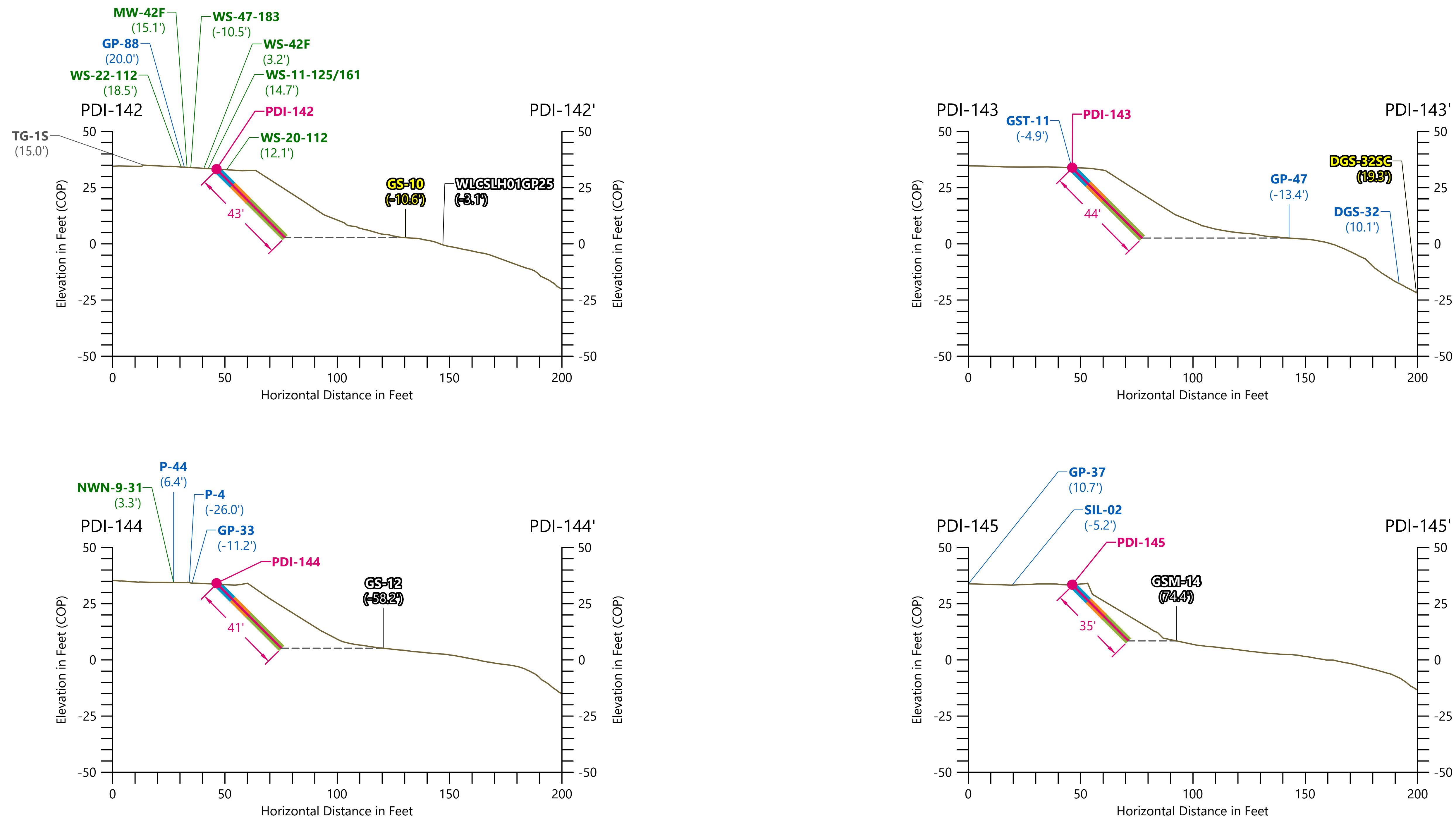
Figure 10b
Proposed Angled Top of Riverbank Borings – Riverbank Borings PDI-138 - PDI-141

Revised Pre-Remedial Design Data Gaps Work Plan
Gasco Sediments Cleanup Action



LEGEND:

●	Proposed Riverbank Core
XX	Existing Sediment/Riverbank Sample Location
XX	Existing Groundwater Monitoring Sample Location
XX	Existing Upland Sample Location
XX	Existing Core with Previously Observed PTW-NAPL
XX	Existing Core without Previously Observed PTW-NAPL
(X.X')	Offset Distance in Feet
	0'-10' Sample Interval
	10'-20' Sample Interval
	20'-Bottom of Core Sample Interval

0 50
Feet

HORIZONTAL DATUM: Oregon State Plane North, North American Datum of 1983 (NAD83/HARN 91), International Feet
VERTICAL DATUM: City of Portland (COP)
NOTE: Sampling will be performed at 0-10 feet, 10-20 feet, and 20 feet to remainder of length shown in each section above on a vertical basis. Actual sample lengths collected from each boring will be longer as a result of the boring being driven at an angle.

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Filepath: K:\Projects\0029-NW Natural Gas Co\Gasco Sediments_Pre-Remedial Design\Pre_RD Data Gaps SAP\0029-RP-004 (Sections).dwg Figure 10c

ANCHOR QEA

Figure 10c
Proposed Angled Top of Riverbank Borings – Riverbank Borings PDI-142 - PDI-145

LEGEND:

- Navigation Channel
- Structures
- Property Line
- Tar Body Removal Action Area (RAPP, Anchor 2005)
- Tar Body Removal Action Pilot Cap
- PTW-NAPL Boundary
- Elevation (feet COP)
- Approximate Riprap Boundary[1]

ROD SMA Technology[2]

- Cap
- Dredge
- Dredge in Nav-FMD
- Dredge with Cap
- 2010 Transition Zone Water Vinyl Chloride Area 1 Boundary (Anchor QEA 2012)[3]
- Area 2 – Detected CVOCs in TZW and One Subsurface Sediment Location[4]

- Pre-RD Group Harborwide Monitoring Subsurface Sample Location (AECOM and Geosyntec 2018a)
- Existing Cores with Previously Observed PTW-NAPL
- Existing Subsurface Sample Location
- Barge Dewatering Treatment and Stabilization Evaluation Core

NOTES:

1. Estimated from side scan sonar survey conducted by Blue Water Engineering April 2011.
2. All depicted SMA technology and PTW contours taken from the Portland Harbor Superfund Site Record of Decision (2017) without application of the EPA Explanation of Significant Differences (ESD; EPA 2018), which is not yet finalized.
3. Boundary taken from Draft Engineering Evaluation/Cost Analysis, Appendix A, Figure 4.2. Transition zone water screening level exceedances of cis-1,2-dichloroethene identified within this vinyl chloride boundary.
4. Boundary taken from Gasco Sediments Site Statement of Work, Figure 1 (EPA 2009).
5. Bathymetry surveyed by DEA 2018. Topography surveyed by Geometrix 2011.
6. Arrow indicates direction of flow of river.
7. Horizontal datum is NAD83 (HARN 91) Oregon State Plane North, International Feet.
8. Vertical datum is City of Portland (COP), Feet.
9. Aerial imagery from City of Portland 2016.

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ANCHOR QEA

Figure 11
Proposed Dredge Material Barge Dewatering Treatment and Stabilization Evaluation Cores

LEGEND:

- Navigation Channel
- Structures
- Property Line
- Tar Body Removal Action Area (RAPP, Anchor 2005)
- Tar Body Removal Action Pilot Cap
- PTW-NAPL Boundary
- Elevation (feet COP)
- Approximate Riprap Boundary[1]

ROD SMA Technology[2]

- Cap
- Dredge
- Dredge in Nav-FMD
- Dredge with Cap
- 2010 Transition Zone Water Vinyl Chloride Area 1 Boundary (Anchor QEA 2012)[3]
- Area 2 – Detected CVOCs in TZW and One Subsurface Sediment Location[4]

- Pre-RD Group Harborwide Monitoring Subsurface Sample Location (AECOM and Geosyntec 2018a)
- Existing Cores with Previously Observed PTW-NAPL
- Existing Subsurface Sample Location
- Existing TCLP Location
- Proposed TCLP/RBC Location

NOTES:

1. Estimated from side scan sonar survey conducted by Blue Water Engineering April 2011.
2. All depicted SMA technology and PTW contours taken from the Portland Harbor Superfund Site Record of Decision (2017) without application of the EPA Explanation of Significant Differences (ESD; EPA 2018), which is not yet finalized.
3. Boundary taken from Draft Engineering Evaluation/Cost Analysis, Appendix A, Figure 4.2. Transition zone water screening level exceedances of cis-1,2-dichloroethene identified within this vinyl chloride boundary.
4. Boundary taken from Gasco Sediments Site Statement of Work, Figure 1 (EPA 2009).
5. Bathymetry surveyed by DEA 2018. Topography surveyed by Geometrix 2011.
6. Arrow indicates direction of flow of river.
7. Horizontal datum is NAD83 (HARN 91) Oregon State Plane North, International Feet.
8. Vertical datum is City of Portland (COP), Feet.
9. Aerial imagery from City of Portland 2016.

TCLP: toxicity characteristic leaching procedure
RBC: risk-based concentration

0 200
Feet

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ANCHOR QEA

Figure 12
Proposed Dredge Material and Riverbank Waste Suitability Characterization Cores and Borings
Revised Pre-Remedial Design Data Gaps Work Plan
Gasco Sediments Cleanup Action

LEGEND:

- Navigation Channel
- Structures
- Property Line
- Tar Body Removal Action Area (RAPP, Anchor 2005)
- Tar Body Removal Action Pilot Cap
- PTW-NAPL Boundary
- Elevation (feet COP)
- Approximate Riprap Boundary[1]

ROD SMA Technology[2]

- Cap
- Dredge
- Dredge in Nav-FMD
- Dredge with Cap
- 2010 Transition Zone Water Vinyl Chloride Area 1 Boundary (Anchor QEA 2012)[3]
- Area 2 – Detected CVOCs in TZW and One Subsurface Sediment Location[4]

- Pre-RD Group Harborwide Monitoring Subsurface Sample Location (AECOM and Geosyntec 2018a)
- Existing Cores with Previously Observed PTW-NAPL
- Existing Subsurface Sample Location

Proposed Additional Analyses Locations

- 0-1 ft
- 0-2 ft, 2-4 ft, 4-6 ft, and 6-8 ft
- 0-2 ft, 2-5 ft, and 5-7 ft[5]

NOTES:

1. Estimated from side scan sonar survey conducted by Blue Water Engineering April 2011.
2. All depicted SMA technology and PTW contours taken from the Portland Harbor Superfund Site Record of Decision (2017) without application of the EPA Explanation of Significant Differences (ESD; EPA 2018), which is not yet finalized.
3. Boundary taken from Draft Engineering Evaluation/Cost Analysis, Appendix A, Figure 4.2. Transition zone water screening level exceedances of cis-1,2-dichloroethene identified within this vinyl chloride boundary.
4. Boundary taken from Gasco Sediments Site Statement of Work, Figure 1 (EPA 2009).
5. The nearshore core locations may need to be adjusted further offshore depending on the river elevations during sample collection to facilitate vessel access.
6. The non-site-specific categorization is based on historical and current operations.
7. Bathymetry surveyed by DEA 2018. Topography surveyed by Geometrix 2011.
8. Arrow indicates direction of flow of river.
9. Horizontal datum is NAD83 (HARN 91) Oregon State Plane North, International Feet.
10. Vertical datum is City of Portland (COP), Feet.
11. Aerial imagery from City of Portland 2016.

0 200
Feet

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Figure 13
Proposed Additional Analyses Locations for Non-Site-Specific COCs

Appendix A
Pre-Remedial Design Data Gaps Field Sampling Plan

ECSI No. 84
September 11, 2019
Gasco Sediments Cleanup Action

Pre-Remedial Design
Data Gaps Field Sampling Plan

Prepared for U.S. Environmental Protection Agency, Region 10

ECSI No. 84
September 11, 2019
Gasco Sediments Cleanup Action

Pre-Remedial Design
Data Gaps Field Sampling Plan

Prepared for
U.S. Environmental Protection Agency
Region 10
1200 Sixth Avenue
Seattle, Washington 98101

Prepared by
Anchor QEA, LLC
6720 SW Macadam Avenue
Suite 125
Portland, Oregon 97219

On Behalf of
NW Natural
220 NW 2nd Avenue
Portland, Oregon 97209

Project Number: 000029-02.59
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ABBREVIATIONS

ASTM	ASTM International (formerly American Society for Testing and Materials)
BGP	biogas generation potential
bml	below mudline
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cm	centimeter
COC	contaminant of concern
COD	chemical oxygen demand
COP	City of Portland datum
CPTu	cone penetration test with pore pressure measurement
CUL	cleanup level
Data Gaps Investigation	Pre-Remedial Design Data Gaps Investigation
DEQ	Oregon Department of Environmental Quality
DGPS	differential global positioning system
DNAPL	dense nonaqueous phase liquid
DOC	depth of contamination
DQO	data quality objective
EGL	Environmental Geochemistry Laboratory
EPA	U.S. Environmental Protection Agency
FFP	full-flow penetration
FSP	*Pre-Remedial Design Data Gaps Field Sampling Plan*
GAC	granular activated carbon
GPS	global positioning system
HARN91	High Accuracy Reference Network 91
HDPE	high-density polyethylene
IDW	investigation-derived waste
Interim Project Area	Gasco Sediments Site active cleanup boundaries
LOC	labile organic carbon
mg/L	milligrams per liter
NAD83	North American Datum of 1983
NAPL	nonaqueous phase liquid
NRC	not reliably contained
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PTFE	polytetrafluoroethylene
PTW	principal threat waste
QA	quality assurance

QAPP	*Pre-Remedial Design Data Gaps Quality Assurance Project Plan*
QC	quality control
RCRA	Resource Conservation and Recovery Act
RBC	risk-based concentration
RAL	remedial action level
ROD	*Record of Decision*
Siltronic	Siltronic Corporation
Site	Gasco Sediments Site
SOW	*Statement of Work*
SVOC	semivolatile organic compound
SPT	standard penetration test
TCE	trichloroethene
TEWP	*Final Revised Pre-Remedial Basis of Design Technical Evaluations Work Plan*
TOC	total organic carbon
TCLP	toxicity characteristic leaching procedure
TFE	tetrafluoroethylene
TPH	total petroleum hydrocarbons
TS	total solids
TSS	total suspended solids
USCS	Unified Soil Classification System
vibracore	vibratory core sampling
VOC	volatile organic compound
WBZ	water-bearing zone
Work Plan	*Pre-Remedial Design Data Gaps Work Plan*

1 Introduction

This *Pre-Remedial Design Data Gaps Field Sampling Plan* (FSP) has been prepared by Anchor QEA, LLC, on behalf of NW Natural for the Gasco Sediments Site (Site), located on the Willamette River adjacent to the NW Natural Gasco and Siltronic Corporation (Siltronic) properties in Portland, Oregon (Figure A-1). This FSP has been prepared under the *Administrative Settlement Agreement and Order on Consent* (Docket No. Comprehensive Environmental Response, Compensation, and Liability Act [CERCLA] 10-2009-0255) and attached *Statement of Work – Gasco Sediments Site* (SOW; EPA 2009) and the Schedule of Deliverables approved by the U.S. Environmental Protection Agency (EPA) on June 19, 2017. This FSP presents the data objectives, the proposed field sampling and data collection methodologies, and the analytical testing to be conducted during the implementation of the Pre-Remedial Design Data Gaps Investigation (Data Gaps Investigation) at the Site.

1.1 Purpose and Objectives of the Field Sampling Plan

This FSP, which is Appendix A of the *Revised Pre-Remedial Design Data Gaps Work Plan* (Work Plan), details the methods and processes that will be used to collect data in support of the objectives laid out in the Work Plan. The Data Gaps Investigation is being implemented to collect additional site-specific data to refine as necessary the Site active cleanup boundaries (herein termed the Interim Project Area to maintain consistency with the terminology used in the Site SOW [EPA 2009]) identified in the *Draft Engineering Evaluation/Cost Analysis* (Anchor QEA 2012), as well as to support completion of the technical evaluations presented in the *Final Pre-Remedial Basis of Design Technical Evaluations Work Plan* (TEWP; Anchor QEA 2019a).

1.2 Data Quality Objectives

The Data Gaps Investigation data quality objectives (DQOs) are discussed in detail in the Work Plan. References to where DQOs are presented in the Work Plan are included in each investigation component's individual subsection in Section 3 of this report.

1.3 Document Organization

The remainder of this document is organized into the following sections:

- Section 2 – Project Management and Responsibilities
- Section 3 – Sample Collection, Processing, and Handling Procedures
- Section 4 – Field Documentation, Sample Handling, Decontamination Procedures, and Investigation-Derived Waste Management
- Section 5 – Chemical and Physical Testing
- Section 6 – Field Sampling Schedule
- Section 7 – References

2 Project Management and Responsibilities

This section describes the project management structure for implementing this FSP. Additional information about staff responsible for project management and other roles is defined in the *Pre-Remedial Design Data Gaps Quality Assurance Project Plan* (QAPP; Appendix B of the Work Plan).

The project manager for Anchor QEA is Mr. Ryan Barth. Mr. Barth will be responsible for overall project coordination and providing oversight on planning and coordination, all project deliverables, and performance of the administrative tasks needed to ensure timely and successful completion of the project. He will also be the main point of contact for the EPA regional project manager.

The field coordinator from Anchor QEA is Mr. Nik Bacher. Mr. Bacher will provide overall direction for the sampling program in terms of logistics, personnel assignments, and field operations. Furthermore, he will be responsible for managing field activities and general field quality assurance/quality control (QA/QC) oversight. He will ensure that appropriate protocols for sample collection, preservation, and holding times are observed and oversee delivery of environmental samples to the designated laboratories for chemical and physical analyses.

The project chemist will be Ms. Delaney Peterson. Ms. Peterson's responsibilities will include coordination with laboratories regarding sample receipt, requested analyses, and turnaround times. She will also answer technical and logistical questions related to the analyses requested, including issues related to limited sample availability, which impact detection limits and matrix interferences.

Sample analysis will be conducted by pre-qualified laboratories, and the laboratory project managers will act as the primary points of contact at each analytical laboratory, as discussed in the QAPP. The project chemist will communicate with the laboratory project managers to resolve sampling, receipt, analysis, and storage issues. Multiple laboratories will be analyzing samples during the data gaps sampling program; each laboratory will have a laboratory project manager.

3 Sample Collection, Processing, and Handling Procedures

The surface and subsurface sediment sampling methods described in this document were previously presented in the EPA-approved *Final Project Area Identification Report and Data Gaps Quality Assurance Project Plan* (Anchor QEA 2010). The riverbank angled borings, porewater sampling, ebullition monitoring, nonaqueous phase liquid (NAPL) mobility, gas ebullition-facilitated sheen sampling, dredge material haul barge dewatering characterization, geotechnical coring, and in situ penetration testing methods have not been previously used at the Site. Components of this work that rely on ASTM International (ASTM) methods will refer to currently adopted versions of the methods to ensure data quality.

To complete the field activities, Anchor QEA will work with qualified health- and safety-focused subconsultants to complete the following field programs:

- Surface sediment sampling
- Riverbank angled borings
- Sediment coring
- Porewater sampling
- Gas ebullition monitoring
- Gas ebullition sheen sampling
- Geotechnical drilling
- In situ penetration testing and testing of sediment and native material

3.1 PTW-NAPL Identification

Anchor QEA will visually inspect the full depth of each individual sediment grab sample, riverbank boring, sediment core, and geotechnical boring (where sediment is retrieved onto the vessel) and will note the presence of principal threat waste (PTW)-NAPL and the depth interval of occurrence.

PTW-NAPL will be identified in accordance with the site-specific visual definition, defined in Section 3.6.2.1 of the Site SOW (EPA 2009) as "any layer or seam of product, regardless of thickness, that is clearly defined as liquid NAPL that is also mobile (i.e., 'oozes' or 'drips' out of the core during core observations)."

Small depressions will be made in each surface grab, boring, and core in areas showing both the visual absence and presence of petroleum-impacted soils and sediments to evaluate the presence of PTW-NAPL. If NAPL freely flows into a depression, additional depressions will be made immediately above and below to delineate the depth of PTW-NAPL. Intervals that are determined to have PTW-NAPL may have material sampled and subjected to shake tests, as described in Section 3.4.5.

3.2 Surface Sediment Sampling

Sections 3.2.1 through 3.2.3 describe the sample collection, processing, and handling procedures to be followed during the collection of surface sediment samples during the Data Gaps Investigation. The QAPP outlines the analytical methods and details the QA/QC protocols to be followed during these activities.

3.2.1 Surface Sediment Sampling Plan

As described in Section 3 of the TEWP (Anchor QEA 2019a), the intent of the surface sediment sampling program is to collect additional information to achieve the following objectives:

- Refine the Interim Project Area.
- Provide additional surface sediment data density in the Interim Project Area.
- Evaluate the sediment quality of depositional sediments that have migrated into the Gasco Early Action Area constructed in 2005, and provide results for all Portland Harbor Superfund Site contaminants of concern (COCs) associated with remedial action level (RAL) and PTW thresholds (including non-site-specific COCs[1]) for surface samples collected in support of the Gasco remedial design.

To achieve these objectives, surface sediment samples will be collected at five locations to refine the Interim Project Area boundary (Figure A-2), four locations to provide additional data density (Figure A-2), and four locations in the Early Action Area pilot cap footprint (Figure A-8). Each of these surface sediment grab samples will be analyzed for the Portland Harbor Superfund Site COCs associated with RAL and PTW thresholds identified in Table 21 of the *Record of Decision* (ROD; EPA 2017). Sample location IDs and proposed coordinates are shown in Table A-1. Chemical testing is discussed in Section 5. Analytical methods and QA/QC information are discussed in the QAPP.

3.2.2 Surface Sediment Collection Methods

The surficial sediment sampling protocols used in this investigation are consistent with those conducted as part of the EPA-approved *Final Project Area Identification Report and Data Gaps Quality Assurance Project Plan* (Anchor QEA 2010), the “Revised NW Natural Proposed Spring 2018 Interim Pre-Remedial Design Data Gaps Field Sampling – Gasco Sediments Site” memorandum (Anchor QEA 2018a), and the *Portland Harbor Pre-Remedial Design Investigation and Baseline Sampling Surface Sediment Field Sampling Plan* (AECOM and Geosyntec 2018a). The remainder of this section and Section 3.2.3 present the surface sediment sample collection and processing methods. The analytical testing methods associated with these programs are described in Section 5.1.

[1] The non-site-specific categorization is based on historical and current operations.

Surface sediment samples will be collected using either a hydraulic or gravity-driven Van Veen grab sampling device capable of collecting a sample to a minimum depth of 1 foot below mudline (bml). Sampling locations will be located using a differential global positioning system (DGPS), and the proposed sampling location coordinates are provided in Table A-1. The sampling locations will be approached at slow boat speeds to minimize the disturbance of bottom sediments. Prior to collecting each sample, the depth to mudline will be determined using a calibrated fathometer or lead line.

3.2.2.1 Interim Project Area Refinement and Additional Surface Sediment Data Density

At each surface sediment location (except the four Early Action Area pilot cap depositional sediment surface sediment locations—see the methods described further in this section), three grab samples will be collected in a triangular pattern with an equidistant spacing of approximately 25 feet around the proposed target location. Each of these subsamples will be composited and homogenized into one sample as further described in this section. The final sample location will be reported as the centroid of the triangle formed by the three subsample locations after post-processing the global positioning system (GPS) data. During the collection of each subsample, the grab sampler will be lowered over the side of the boat using a winch and davit connected to a cable at an approximate speed of 0.3 feet per second. When the sampler reaches the mudline, the sampler will be closed, and DGPS coordinates will be recorded. The sampler will be weighted as necessary to help achieve the target penetration depth and acceptance criteria. At this time, the depth to mudline will be determined using a calibrated fathometer or lead line. The sampler will be retrieved aboard the vessel and evaluated for acceptance based on the following criteria:

1. Overlying water is present, and the turbidity does not visually suggest disturbance of the mudline.
2. Sampler is not overfilled.
3. Sediment surface appears visually undisturbed.
4. There are no visual signs of winnowing or leaking from the sampling device.
5. At least 8 inches of material is recovered, consistent with the criteria in the *Portland Harbor Pre-Remedial Design Investigation and Baseline Sampling Surface Sediment Field Sampling Plan* (AECOM and Geosyntec 2018a).

Grab samples not meeting these criteria will be rejected and the sample collection steps repeated until the acceptance criteria are met, but no more than six individual subsample attempts will occur at each composite location, and the three attempts with the highest recovery will be retained. If the composite average recovery is greater than 0.3 feet, the sample will be retained for analysis. Deployments will be repeated within an approximately 10-foot radius of the target subsample location. Subsample locations may be adjusted based on unexpected field conditions (e.g., presence of riprap, large debris, or other obstructions). If no material is recovered after two attempts at a subsample location, the location will be offset to a maximum of a 50-foot radius from the target location. If adequate recovery is not achieved (i.e., 8 inches) after two attempts at a target subsample location, the grab with the largest recovery will be accepted and noted in the field log and surface sediment sample log. All grab samples, regardless of acceptance, will be logged as they are collected, and accepted subsamples will be processed as described in Section 3.3.3. Representative volumes from the full recovered depth of each subsample grab will be collected in separate decontaminated stainless-steel bowls and covered with aluminum foil. Once all three acceptable subsamples have been collected, an approximately equal volume aliquot of each of the three subsample grabs will then be composited and homogenized to create the final sample for that location. The sampler will be rinsed with river water to remove all solid material between subsample grabs and decontaminated after completing the sampling at a given location using the procedures identified in Section 4.3.

Visual observations for PTW-NAPL using the site-specific definition will be made on the sediment surface and throughout the entire depth, by sequentially removing 4-inch sediment layers until the bottom of the sampler is reached, for each individual grab sample collected using the logging and processing procedures identified in Section 3.2.3. All surface sediment grab sample information and observations will be recorded in the field log and in the surface sediment sample log sheet (Attachment A) following the specifications in Section 3.3.3.

3.2.2.2 Early Action Area Pilot Cap Depositional Sediment

In contrast to the three-point composites subsampled for the Interim Project Area refinement and additional surface sediment data density, the depositional sediment overlying the placed Early Action Area pilot cap material will be collected from the four discrete (due to the small sampling footprint) locations shown in Figure A-8. The samples will be collected using the same equipment and methods identified in Section 3.2.2.1 except for the following revisions. Based on sampling of the depositional sediments during long-term monitoring of the pilot cap between 2005 and 2008, it is anticipated that less than 10 centimeters (cm) of depositional sediment may be present overlying the pilot cap materials. Therefore, only sample acceptance criteria 1 through 4 summarized in Section 3.2.2.1 will apply (i.e., excludes criteria 5 requiring an 8-inch recovery depth). Whatever thickness of depositional sediment that is retrieved and achieves recovery criteria 1 through 4 will be accepted. Multiple samples that are slightly offset (within 20 feet of the target location) may need to be collected from a single station if the thickness of depositional sediment is insufficient for laboratory analyses of the target analyte list. In this case, the multiple samples will be composited and homogenized to create a single sample. It is anticipated that the sampler weighting may need to be adjusted to attempt to minimize collection of the pilot cap materials if these materials are impacting the ability to achieve the sample acceptance criteria.

Visual observations for PTW-NAPL using the site-specific definition will be made on the sediment surface and throughout the full subsampling depth using the logging and processing procedures identified in Section 3.2.3. All surface sediment grab sample information and observations will be recorded in the field log and in the surface sediment sample log sheet (Attachment A) following the specifications in Section 3.3.3.

3.2.3 Surface Sediment Logging and Processing Procedures

The following procedures will be used to log and process accepted surface sediment samples:

- Siphon off water overlying the mudline, taking care not to remove sediment.
- Take digital photographs of each grab with a label indicating project, sample location, and date.
- Record the sample description on the grab sample log form, including, but not limited to, the following observations as appropriate:
  - Physical soil description in accordance with the Unified Soil Classification System (USCS) (ASTM D2488 – Standard Practice for Description and Identification of Soils (Visual-Manual Procedures)) including soil type, density/consistency, color, and other similar descriptors
  - Presence of PTW-NAPL and other signs of petroleum contamination (e.g., sheens)
  - Odor (e.g., hydrogen sulfide, petroleum)
  - Presence of organic material (e.g., vegetation, roots, and twigs)
  - Anthropogenic debris
  - Biological activity (e.g., shells, tubes, bioturbation, or organisms)
  - Any other distinguishing characteristics or features
- Materials in the sample more than 2 inches in diameter and debris will not be subsampled into sample containers.
- Visually assess the presence of PTW-NAPL using the site-specific definition provided in Section 3.1. Prior to subsampling for chemical analyses, depressions will be made in the sediment using a decontaminated stainless-steel spoon or similar to evaluate for the presence of liquid NAPL that is also mobile (i.e., oozes or drips out of the sample during processing).
- Collect the upper 1 foot (i.e., 30 cm), or less if acceptance recovery criteria are met, of sediment without touching the sidewalls using a decontaminated stainless-steel trowel or equivalent. Place the sediment into a single decontaminated stainless-steel bowl and homogenize until uniform color and texture are achieved.
- One archive jar may be collected for each grab subsample in case it is later determined that individual analyses could be useful to refine the results of the composite sample.
- Once homogenized, a bowl containing representative material from each subsample grab for a location will be covered with tinfoil and placed on ice.

- Once all three subsample grabs have been successfully collected, a decontaminated stainless-steel spoon will be used to place a proportionate volume of sediment from each grab into a single cleaned stainless-steel bowl and homogenize until uniform color and texture is achieved.
- Using a decontaminated stainless-steel spoon, fill pre-labeled, laboratory-provided sample containers for sediment chemistry analysis.
- Immediately place filled and sealed sample containers in a cooler with ice to maintain temperature at approximately 4°C until delivered to the project laboratory, while following the handling and chain-of-custody procedures described in Section 4.2.3. The required sample volumes , preservation, and maximum holding times for the categories of analytes are presented in the QAPP.

3.3 Riverbank Angled Borings

Sections 3.3.1 through 3.3.4 describe the sample collection, processing, and handling procedures to be followed during the collection of samples from riverbank angled borings during the Data Gaps Investigation sampling by the selected drilling contractor. The QAPP outlines the analytical methods and details the QA/QC protocols to be followed during these activities.

3.3.1 Riverbank Angled Borings Sampling Plan

As described in Section 3.3.1 of the TEWP, the objective of the riverbank angled borings sampling program is to collect additional information to further evaluate the vertical and lateral extents of PTW-NAPL/not reliably contained (NRC), PTW-highly toxic threshold, and RAL exceedances in the riverbank to support remedial technology evaluations.

To achieve this objective, twelve borings will be advanced on top of the riverbank as shown in Figure A-3. Sample IDs, proposed boring depths, and proposed coordinates are provided in Table A-2. Chemical testing is discussed in Section 5. Analytical methods and QA/QC information are discussed in the QAPP.

Each boring has been located as close as accessible to the top of the riverbank immediately downgradient from upland areas containing dense nonaqueous phase liquid (DNAPL) in the Fill water-bearing zone (WBZ) based on data presented in the *Interim Feasibility Study* for the Gasco Operable Unit (Anchor QEA 2018b). Each boring bottom depth is based on the elevation of the top of the nearest in-water toe-of-slope core. These advancement depths will fully characterize the wedge of material that resides between existing upland borings and the top of toe-of-slope cores.

3.3.2 Riverbank Angled Boring Collection Methods

The borings will be advanced by a sonic drill rig after clearing the target location as necessary to facilitate access. The target locations may need to be adjusted based on contractor access. The drill rig will be set up so the core barrel enters the ground at an angle approximating the angle of the riverbank slope, but it will be no less than 45 degrees and no more than 90 degrees. This angle will be confirmed in the field using an inclinometer. Continuous soil samples will be obtained and sampled at the frequency and depth intervals identified in Table A-2.

3.3.3 Soil Logging and Processing Procedures

To account for the angled boring, the corrected depth is the vertical distance from the ground surface if the core barrel was oriented perpendicular to the ground surface. Corrected sample depths will be determined using Equation 1.

Equation 1

$$Vertical\ Depth\ Below\ Ground\ Surface = Sampler\ Distance\ Pushed\ from\ Ground\ Surface * \sin(entry\ angle\ of\ boring)$$

The following description provides a detailed account of the boring sample processing procedures:

- Lay out the sample bags horizontally for each run at a boring location. Cut the bags longitudinally using scissors to minimize penetration and disturbance of the soil during cutting.
- Immediately following the opening of the sample bag, representative volatile organic compound (VOC) samples from the target intervals will be collected using a clean t-bar and placed into a pre-labeled container with methanol preservative. The sample will be collected prior to homogenization to minimize volatilization. The container lid will be closed tightly and examined to minimize the potential for excess sediment inhibiting a tight seal.
- Following VOC subsampling and prior to subsampling for the remainder of the chemical analyses, visually assess the presence of PTW-NAPL using the site-specific definition provided in Section 3.1. Depressions will be made in the sediment using melon baller to evaluate for the presence of liquid NAPL that is also mobile (i.e., oozes or drips out of the sample during processing).
- Record the description of the full length of the borehole on the boring log form, including but not limited to the following observations, as appropriate:
  - Sample recovery (recovered soil depth relative to penetration depth and percent compaction)
  - Physical soil description in accordance with USCS (ASTM D2488 – Standard Practice for Description and Identification of Soils (Visual-Manual Procedures)) including soil type, density/consistency, color, and other similar descriptors)
  - Presence of PTW-NAPL and other signs of petroleum contamination (e.g., sheens)
  - Odor (hydrogen sulfide, petroleum)

    - Presence of organic material (e.g., vegetation, roots, and twigs)
    - Anthropogenic debris
    - Any other distinguishing characteristics or features
- Take digital photographs of each borehole sample interval with a label indicating the location and depth of the interval.
- The sampling intervals in each boring are identified in Table A-2.
- Using a decontaminated stainless-steel spoon, place a proportionate volume of soil from the identified sample interval(s) into a single cleaned stainless-steel bowl and homogenize until uniform color and texture is achieved.
- Using a decontaminated stainless-steel spoon, fill pre-labeled, laboratory-provided sample containers for all proposed analyses.
- Immediately place filled and sealed sample containers in a cooler with ice to maintain temperature at approximately 4°C until delivered to the project laboratory, while following the handling and chain-of-custody procedures described in Section 4.2.3. The required sample volumes, preservation, and maximum holding times for the categories of analytes are presented in the QAPP.

3.3.4 Soil Boring Abandonment

Soil borings will be abandoned using the approach approved at the upland Gasco property by the Oregon Department of Environmental Quality (DEQ) and Oregon Water Resources Department (Bayuk 2009). The bentonite grout slurry that will be placed from the bottom of the borehole to the mudline or ground surface using a tremie pipe. The discharge end of the tremie pipe will be submerged in the grout to avoid breaking the seal while filling the borehole. For intervals where NAPL is present, as determined by visual inspection of recovered soil samples for presence of PTW-NAPL, the grout slurry will consist of a bentonite/organoclay blend consisting of approximately 9 parts Wyoming sodium bentonite and 1 part organoclay by volume, mixed to a 20% solids content. The resulting mud weight of the 20% solids solution will be approximately 9.5 to 9.7 pounds per gallon. The use of granular bentonite across the portion of the borehole within the vadose zone is an acceptable alternative to the placement of the grout slurry across this zone.

3.4 Subsurface Sediment Sampling

Sections 3.4.1 through 3.4.5 describe the subsurface sediment sample collection, processing, and handling procedures to be followed during the Data Gaps Investigation sampling to be performed by Anchor QEA. The QAPP details the QA/QC protocols to be followed during these activities.

3.4.1 *Subsurface Sediment Sampling Plan*

As described in the TEWP, the intent of the subsurface sediment sampling program is to collect additional information to evaluate the following:

- Capping demonstration evaluation using multiple lines of evidence approach
  - Chemical isolation components (Section 3.2.1.1 of the TEWP) including:
    - Porewater concentrations calculated from bulk sediment
    - Paired bulk subsurface sediment and co-located porewater samples to develop site-specific equilibrium partitioning coefficients for VOCs (sampling discussed in Section 3.5)
    - Subsurface porewater samples in contact with PTW-NAPL sediments
  - NAPL mobility testing (Section 3.2.2.1 of the TEWP)
    - PTW-NAPL transport from advection
    - Gas ebullition-facilitated transport of PTW-NAPL (sampling discussed in Sections 3.6 and 3.7)
    - PTW-NAPL loading to the cap from sediment consolidation
  - Geotechnical components (Section 3.2.3.1 of the TEWP) discussed in Section 3.9
    - Stability, bearing capacity, and consolidation
- Dredging evaluation (Section 3.4.1 of the TEWP)
  - Determine the vertical extent of depth of contamination (DOC) to allow for dredge prism development that removes the full vertical extent of contamination.
  - Refine PTW-NAPL boundary with the sediment management areas that are driven by RAL and PTW threshold exceedances.
  - Use geotechnical information collected from capping demonstration (discussed in Section 3.9) to inform dredge side slope sloughing and necessary lateral offsets from existing functional structures.
  - Determine presence and extent of shoreline riprap that may limit the depth of dredging in shoreline areas. This survey will be conducted under a separate work plan (Anchor QEA 2019b).
- Waste handling and disposal evaluation (Section 3.5.1 of the TEWP)
  - Pre-characterize wastes associated with dredging to determine appropriate dredge sediment waste handling and transport options and to complete the waste disposal classification evaluation.
- Additional analyses evaluation (Section 3.6.1 of the TEWP)
  - Provide results for all Portland Harbor Superfund Site COCs associated with RAL and PTW thresholds for surface and shallow subsurface samples collected in support of Gasco remedial design.
  - Provide additional chemical characterization of PTW-NAPL at the Site.

To achieve these objectives, 20-foot sediment cores will be collected as follows:

- For the capping demonstration evaluation, collect 87 cores as shown in Figure A-4. Cores located in the ROD-identified dredge and cap areas are co-located with the DOC cores.
- For the dredging evaluation, collect 72 DOC cores as shown in Figure A-5.
- For the waste handling and disposal evaluation, collect 12 cores for dredge barge material dewatering and stabilization evaluation as shown in Figure A-6 and 12 cores for dredge material waste suitability characterization evaluation as shown in Figure A-7. In addition, collect 6 angled riverbank borings for dredge material waste suitability characterization evaluation as shown in Figure A-7.
- For the additional analyses evaluation, collect samples from 46 co-located DOC cores and 15 capping only cores shown in Figure A-8. In addition, collect samples from two additional 20-foot vibracores located outboard of the PTW-NAPL boundary, as shown in Figure A-2.

Sample IDs and proposed coordinates for each program are shown in Table A-3, and proposed sampling depths are shown in Table A-4. Chemical testing is discussed in Section 5. Analytical methods and QA/QC information are discussed in the QAPP. The proposed locations may change based on field conditions (e.g., presence of riprap, accessibility based on existing structures, and lack of sufficient water depth).

The subsurface sediment sampling protocols used in this investigation are consistent with the protocols in the EPA-approved *Final Project Area Identification Report and Data Gaps Quality Assurance Project Plan* (Anchor QEA 2010) and the *Portland Harbor Pre-Remedial Design Investigation and Baseline Sampling Subsurface Sediment Coring Field Sampling Plan* (AECOM and Geosyntec 2018b).

3.4.2 Subsurface Sediment Collection Methods

Subsurface sediment samples will be collected using vibratory core sampling (vibracore) methods. Sampling locations will be located using a DGPS and the proposed sampling location coordinates are provided in Table A-3. Prior to collecting each core, the depth to mudline will be determined using a calibrated fathometer or lead line.

Subsurface sediment will be collected in 3.75-inch-inside-diameter aluminum core tubes with a stainless-steel core catcher riveted to the bottom end. Core tubes will be decontaminated prior to use following the protocols outlined in Section 4.3. Care will be taken during sampling to avoid contact of the core tube with potentially contaminated surfaces. Extra core tubes will be available during sampling operations for uninterrupted sampling in the event of a potential core tube breakage or contamination. Core tubes suspected to have been accidentally contaminated will not be used.

The vibracore will be deployed from the bow of the vessel using an A-frame and winch assembly. A 20-foot decontaminated aluminum pipe will be clamped to the vibracore. If the location is on a sloping mudline, the vibracore base can be reconfigured to attempt to match the slope to facilitate vertical penetration of the core. Once in position, the vibracore unit will be deployed, energized, and driven to a maximum of 20 feet bml or refusal. The physical characteristics at each proposed sampling location are anticipated to be variable precluding an accurate estimation of the core recovery at each location prior to collection. Once a penetration of 20 feet bml or refusal occurs, the vibracore will be turned off and returned to the surface for comparison to the sample acceptability criteria. The location of refusal will be recorded using a DGPS for future reference. The penetration depth will be evaluated based on data from the vessel's onboard penetration monitor and marker rings attached to the side of the vibracore base guiding rods that are pushed up on the guiding rods as the core barrel is driven into the sediments. Upon retrieving a core, the following information will be recorded:

- Date and time the core was collected
- Depth to mudline
- Total drive length
- Recovered length
- Overlying water is present, and the core surface is intact
- Core tube is in good condition and not excessively bent
- Preliminary assessment of sediment characteristics contained in the core catcher at the bottom of the tube
- Project name, location, and sampling date on an appropriately labeled photograph

To determine if a core is suitable for processing, the following acceptability criteria will be used:

1. Recovery was at least 70% of the length of core penetration. A target core recovery of 70% was determined to be appropriate based on an assessment of historical data collected within the Interim Project Area. If refusal or poor recovery (see Figure A-9) is consistently encountered during coring, a change in approach (e.g., reduce number of required attempts) will be discussed with EPA.
2. Cored material did not extend out the top of the core tube or contact any part of the sampling apparatus at the top of the core tube.
3. There were no obstructions noted in the core catcher that might have blocked the subsequent entry of sediment into the core tube and resulted in incomplete core collection.

Core tubes longer than 4 feet will be cut to facilitate upright storage and truck transport to the processing location. The cut tubes will be individually labeled and sealed with core caps taped over with duct tape to prevent material loss during transport. Core orientation will also be noted on each tube. Labels identifying the core section will also be securely attached to the outside of the tube using tape and waterproof ink or by scribing the information into the core tube with a metal screwdriver. The core sections will be stored upright in the core storage box on the boat until transferred to the uplands core processing area. Ice will be added to the core storage box on the boat if the core sections are kept on the boat for extended periods (e.g., not transferred in the middle of the day and at the end of each day). At the uplands core processing area, the core sections will be stored approximately upright in iced containers, or in a refrigeration unit, in the appropriate orientation until core processing is conducted. If multiple core rejections (three attempts) occur within a 20-foot radius of the planned location, the core with the best recovery will be deemed acceptable and processed. If moving a core location (location X) due to refusal, low recovery, or obstruction results in that location being collected within 50 feet of another proposed core location (location Y), then the second proposed location (location Y) may not be collected. In some of the proposed nearshore locations, the cores may need to be relocated further channelward if riprap is encountered on the mudline that prevents adequate core recovery.

3.4.3 Subsurface Sediment Core Logging and Processing Procedures

All cores will be carefully transferred from the sampling vessel to large containers full of ice at a designated shoreside location where processing will be conducted. The anticipated processing facility is on the Gasco property along the central portion of the property near the top of the riverbank area. Core processing occurred in this same location during completion of the *Final Project Area Identification Report and Data Gaps Quality Assurance Project Plan* (Anchor QEA 2010). At the processing facility, cores will be cut open horizontally on a table and logged.

At each target core location, a variety of samples will be collected to achieve multiple sampling objectives. Therefore, to minimize the number of cores that need to be collected to obtain sufficient sample volume, one half of the core tube will be sampled for DOC analysis and additional analytes (where proposed), and the other half will be sampled for analytes specific to the capping demonstration and gas ebullition evaluations. Waste characterization and barge dewatering cores will be co-located but collected via separate cores to ensure sufficient sample volume for analysis.

The following is a detailed account of the core processing procedures:

- Lay out the core tubes for the entire penetration depth for a sampling location. Cut the core tubes longitudinally using a circular saw, setting the saw blade depth to minimize penetration and disturbance of the sediment during cutting.
- Immediately following opening of the core for VOC sampling (not homogenized), representative samples from the necessary intervals will be collected using a clean t-bar and placed into a pre-labeled container with methanol preservative. The sample will be collected prior to homogenization to minimize volatilization. The container lid will be closed tightly and examined to minimize the potential for excess sediment inhibiting a tight seal. Additional

volume will be collected from the core and archived pending future potential VOC analysis (e.g., treatability testing) within the appropriate hold time.

- For core intervals selected for biogas generation potential (BGP) evaluation, half of the core will be transferred to a pre-labeled Mylar barrier bag and sealed immediately after the core is cut. If the target interval includes multiple sections of core, each section will be bagged individually, and compositing/homogenization will occur in the laboratory under a nitrogen atmosphere.
- Visually assess for the presence of PTW-NAPL using the site-specific definition provided in Section 3.1. Depressions will be made in the sediment using a melon baller to evaluate for the presence of liquid NAPL that is also mobile (i.e., oozes or drips out of the sample during processing). Intervals containing PTW-NAPL may have material sampled and subjected to the extraction processes described in Section 3.4.5.
- Record the description of the full length of the core sample on the core log form, including but not limited to the following observations, as appropriate:
  - Sample recovery (recovered sediment depth relative to penetration depth and percent compaction)
  - Physical soil description in accordance with USCS (includes soil type, density/consistency, color, and other similar descriptors)
  - Presence of PTW-NAPL and other signs of petroleum contamination (e.g., sheens)
  - Odor (e.g., hydrogen sulfide, petroleum)
  - Presence of organic material (e.g., vegetation, roots, and twigs)
  - Anthropogenic debris
  - Biological activity (e.g., shells, tubes, bioturbation, or organisms)
  - Any other distinguishing characteristics or features
- Take digital photographs of each 1-foot core interval with a label indicating the location and depth of the core interval.
- Identify sample intervals in each core per Table A-4.
- Using a decontaminated stainless-steel spoon, place a proportionate volume of sediment from the identified sample interval(s) into a single cleaned stainless-steel bowl or high-density polyethylene (HDPE) bucket and homogenize until uniform color and texture is achieved.
- Using a decontaminated stainless-steel spoon, fill pre-labeled, laboratory-provided sample containers for all proposed analyses. Some portion of the remaining volume following filling of the sample containers will be placed into additional laboratory-provided sample containers for potential future analysis (e.g., treatability testing).
- Immediately place filled and sealed sample containers in a cooler with ice to maintain temperature at approximately 4°C until delivered to the project laboratory, while following the handling and chain-of-custody procedures described in Section 4.2.3. The required sample

volumes, preservation, and maximum holding times for the categories of analytes are presented in the QAPP.

3.4.4 Subsurface NAPL Mobility Core Processing Procedures

Six subsurface sediment cores will be collected for NAPL mobility assessment at locations determined in the field based on field observations of the presence of PTW-NAPL in subsurface cores collected for DOC assessment. The goal of the NAPL mobility coring program is to obtain representative, relatively undisturbed sediment samples for laboratory testing of NAPL mobility. To help ensure integrity of the cores from the time of core collection to testing at the laboratory, the following procedures will be used:

- Approximately a 4-foot core sample will be vertically centered on the selected target depth based on identified PTW-NAPL depths during the DOC core logging and through NAPL extraction via shake test (Section 3.4.5).
- All cores will be processed expeditiously following retrieval onto the sampling vessel:
  - Cores will be immediately placed in a vertical position, and the bottom of the core will be capped.
  - The core will then be elevated to a vertical position with the bottom of the core down.
  - Excess core barrel from the top will be trimmed off using a battery-powered saw, and the remaining top of the core containing the sample core will be capped.
  - End caps will be secured with duct tape, and the core recovery will be measured to the nearest tenth of a foot.
  - The top and bottom of the liner will be labeled in permanent ink, and the top depth and boring identification will also be recorded on the liner.
  - The cores will require further cutting to approximately 16-inch lengths so that they can fit into coolers with ice for shipping. Further cutting will be conducted with cores held vertically, with new ends immediately capped and labeled. Aluminum foil may be placed under the cap if it is determined that it is needed to prevent core movement within the sleeve.
  - Core subsections will be labeled as to top and bottom and will contain boring identification. Multiple subcore sleeves from the same core will be labeled sequentially with the letter identifier of that core, to be followed sequentially with numbers (e.g., A1, A2, A3; B1, B2, B3) with A1 at the top (shallowest).
  - Core fluid saturations and structural integrity will be preserved by wrapping each core section in three layers of plastic film.
  - Cores that are collected throughout the day will be shipped vertically into coolers with ice by overnight courier to the laboratory.

The NAPL core samples will be submitted to Core Laboratories in Houston, Texas, (following the chain-of-custody procedures described in Section 4.2.3) for analysis.

3.4.5 Shake Test Procedures

Select sediment core intervals determined to contain PTW-NAPL at six locations during processing using the site-specific PTW-NAPL definition in Section 3.1 will be subjected to a shake test to extract NAPL from the sediment for characterization. If NAPL is successfully separated from the sediment, it will be decanted from the large-scale shake test jar into a glass jar for refrigerated storage. NAPL collected will be stored in separate glass jars depending on the core(s) from which it came. To help ensure the successful extraction of NAPL, the following procedures will be used:

1. Identify the start and end depths of a core interval containing PTW-NAPL (Section 3.2).
2. Perform the large-scale shake test as follows:
    a. Label a 32-ounce container with the location identification, depth interval, date, and time of shake test. Mark a sediment fill line at 1.5 cm from the bottom of the jar and a water fill line at 4.5 cm from the bottom of the jar.
    b. Add sediment up to the sediment fill line on the jar.
    c. Add deionized water and fill to the water fill line on the jar.
    d. Cap the jar and gently invert the jar repeatedly for 10 seconds to suspend the sediment sample.
    e. Place the jar on a flat surface and allow the suspended sediments to settle for a minimum of 5 minutes but no longer than 30 minutes.
    f. NAPL should form a layer at the air-water interface within the jar.
3. Record observations in the field log regarding the color and amount of NAPL separated, where the NAPL settled (air-water or sediment-water interface), the core location number, and the sediment depth interval. If possible, measure the thickness of the accumulated NAPL layer.
4. Take a color photograph of the large-scale shake test container without the lid horizontally and vertically to document the large-scale shake test results. Include the location ID, depth interval, date, and time of the large-scale shake test in the photograph.
5. Decant the accumulated NAPL into a glass storage jar with tight-fitting cap. Separated NAPL will be stored in different glass jars depending on the core from which it was collected as follows:
    a. Label a glass storage jar with the station location from which the NAPL was separated and core depth interval(s).
    b. Gently pour the NAPL from the large-scale shake test jar into the storage jar, taking care to minimize the amount of water or sediment in the NAPL storage jar. Tightly cap the glass storage jar.
6. Using the same large-scale shake test jar that was used in the previous steps, repeat this procedure and attempt to separate additional NAPL, as appropriate .

7. Place the labeled and capped glass storage jars containing separated NAPL into a cooler with ice and/or refrigerator for storage. Based on the volume of NAPL collected and desired NAPL characterization, the NAPL samples can then be shipped to laboratories for testing, while following the handling and chain-of-custody procedures described in Section 4.2.3. The holding times, preservation, and maximum holding times for the categories of analytes are presented in the QAPP.

3.4.6 Centrifuge Testing Procedures

Centrifuge testing will be conducted using specific increments of sediment cores containing the most notable NAPL presence based on core photography under white light and UV light. Test samples will be removed from the core using a plunge cutter, producing cylindrical test samples with approximate dimensions of 2 inches long and 1.5 inches diameter. A non-reactive plug will be placed into the core at this location after test sample removal to avoid disturbing the remainder of the core material. The test samples are placed in hydrostatic cells and will be centrifuged at a controlled temperature and at a force equivalent to 25 times the force of gravity for 10 hours to force drainable fluids to flow from each sample into a calibrated collection receiver.

3.5 Subsurface Porewater Sampling

Sections 3.5.1 through 3.5.3 describe the subsurface porewater sample collection, processing, and handling procedures to be followed during the Data Gaps Investigation sampling to be performed by Anchor QEA. The QAPP details the QA/QC protocols to be followed during these activities.

3.5.1 Subsurface Porewater Sampling Plan

As described in Section 3.4.1, the intent of the subsurface porewater sampling program is to support the site-specific capping demonstrations.

To achieve this objective, subsurface porewater samples will be collected at the 12 locations containing a range of representative VOC concentrations previously measured at the Site, as shown in Figure A-10. Subsurface porewater samples will also be collected at five field-identified locations shown to contain PTW-NAPL during the DOC core logging. These porewater sampling locations will be immediately adjacent to the DOC core locations (Section 3.4).

3.5.2 Subsurface Porewater Collection Methods

Porewater locations will be sampled using a Geoprobe drill rig and screen point sampling system. At each location, the drill rig will advance an approximately 2-foot-long stainless-steel screen point with 0.1-millimeter slots to be centered on the porewater sample target depth. For VOC samples, porewater sample target depths will be 4 to 6 feet bml (identified through the assessment of existing VOC data described in Section 3.2.1.1.2 of the Work Plan). The porewater sample target depth for areas where porewater is in contact with NAPL will be determined in the field based on observations of PTW-NAPL made while logging the DOC cores.

The porewater samples collected from core intervals containing PTW-NAPL may be biased high due to the presence of NAPL in the sample. To minimize NAPL impacting the measured porewater concentrations, each porewater sample collected from the PTW-NAPL depth intervals will be pumped through a ceramic potable-water filter (capillary barrier) to exclude NAPL (Gefell et al. 2018). A porous ceramic water filter is hydrophilic and inert and has extremely small pore spaces to exclude NAPL entry but high porosity and sufficient permeability to allow for aqueous phase sample collection by pumping. Samples collected at locations without PTW-NAPL will not need to be pumped through a ceramic filter.

In addition to porewater sampling, the sediments encountered at the drilling locations will be visually inspected and logged consistent with the procedures identified in Section 3.4.3.

3.5.3 Subsurface Porewater Sampling Procedures and Processing

Porewater samples will be collected using standard groundwater sampling pumps (e.g., peristaltic, Waterra pump, or similar) deployed within the screen point of the drill rods advanced by a Geoprobe. The procedures for installing temporary screen points are as follows:

1. Locate sampling locations using a DGPS.
2. Measure the depth to mudline using a calibrated fathometer or lead line.
3. Fix a decontaminated screen point to the leading end of the drill rods.
4. Lower the screen point to mudline.
5. Advance the screen point to the depth where the approximately 2-foot screen will be centered at the target depth. Record the total depth on the sample collection form, along with the water depth, and complete Sections A through D on the sample collection form (Attachment A).
6. Set extension rods in contact with the top of the screen point.
7. Retract the outer drill rods, thereby exposing the screen point to the formation.
8. Remove the extension rods, leaving a sealed conduit to the screen point.

Once the screen point is properly installed at the target depth, porewater samples will be collected using the following procedures:

1. Prepare a length of pump tubing long enough to reach the bottom of the screen point.
2. Lower the pump tubing to the target sampling depth at the vertical midpoint of the screen point.
3. Connect the top of the tubing to the sample pump (e.g., peristaltic, Waterra pump, or similar).
4. Activate sampling pump at a low initial rate (less than 500 milliliters per minute).

5. Monitor the discharge rate from the sampling pump and the water level within the drill rods to limit drawdown of the water level to 0.3 foot, if practicable.
6. Prior to measuring water quality parameters, purge one full pump tubing volume (i.e., the total volume of the tubing extended to the midpoint of the screen point) using the sampling pump. This volume will be calculated prior to purging based on tubing length used. For reference, the total volume of 0.25-inch tubing is 10 milliliters per lineal foot.
7. Following purging one pump tubing volume, monitor water quality parameters with the water quality meter and electronic water level indicator. These parameters include temperature, pH, specific conductance, visual appearance, and water level; these parameters should be measured every 3 to 5 minutes and recorded on the sample collection form. Water quality parameters will either be measured using a flow-through cell near the discharge point from the pump or in a separate clean container. In addition, note if any sheen is observed at the surface of the discharge water produced at any time during purging.
8. Continue to monitor field water quality parameters until parameters have stabilized or when at least three screen volumes (approximately 770 mL) have been purged after beginning field parameter measurements. Water quality parameters can be considered stabilized when the data are within the following ranges for three consecutive measurements:
    a. ± 0.1 unit for pH
    b. ± 3% for specific conductance
    c. ± 10% for temperature
9. Following stabilization of the water quality parameters or at least three wellpoint screen volumes, collect the porewater sample for chemical analysis using the following procedures:
    a. Attach a new dry ceramic filter to the end of the discharge tubing from the pump. Use additional barbed adaptors, if needed, to convert between tubing sizes. Hold the ceramic filter in an upside-down vertical position at the end of the discharge tubing (with the pump tubing connected at the bottom of the filter and the rounded end of the ceramic filter pointing upward). This position will allow air to be displaced upward out of the filter as it fills with water from below. The water level inside the filter will be recognizable on the outside of the filter as the wetted front moves up the filter. Continue until the entire filter is visibly wetted and water is visibly flowing or dripping from the filter. Then invert the filter for the remainder of the purging and sampling activities.
    b. Prior to sampling, purge the filter of at least one filter volume of water. Note that the total internal volume of the ceramic sampler is approximately 20 milliliters per inch of filter length.
    c. Pump the filtered water directly into pre-labeled, laboratory-provided sample containers.
10. Though not expected, it is possible that highly turbid porewater may clog the porous ceramic filters. Contingency plans will be implemented in coordination with EPA if the filter becomes clogged due to the presence of fine particulates. If water-quality parameters do not stabilize, or

if it is impracticable to purge three screen volumes due to low permeability of the formation, the drill casing and screen may be purged "dry" and porewater sampling can proceed after allowing sufficient time (5 minutes) for the screen to recover, allowing a sample to be collected. If the screen runs dry before the required sample volume has been collected, the screen will be allowed to recover another 5 minutes before the sampling continues.

11. Immediately place filled and sealed sample containers in a cooler with ice to maintain temperature at approximately 4°C until delivered to the project laboratory, while following the handling and chain-of-custody procedures described in Section 4.2.3. The holding times, preservation, and maximum holding times for the categories of analytes are presented in the QAPP.
12. Following sample collection, place disposable pump tubing, ceramic filter, and other disposable sampling equipment in appropriate investigation-derived waste (IDW) containers.

3.6 Gas Ebullition Monitoring

Sections 3.6.1 and 3.6.2 describe the gas ebullition monitoring procedures to be followed during the Data Gaps Investigation sampling to be performed by Anchor QEA.

3.6.1 Gas Ebullition Monitoring Sampling Plan

As described in the Work Plan, the intent of the gas ebullition monitoring program is to assess gas ebullition-facilitated transport of PTW-NAPL. To achieve this objective, two different phases of gas ebullition monitoring will be undertaken during the Data Gaps Investigation, including the following:

- **Phase 1 Gas Ebullition Monitoring:** Interim Project Area-wide observations will be made on 2 consecutive days during late summer low river elevation months. These observations will document the presence of gas ebullition before, during, and after low tide. Emphasis will be placed on monitoring areas where gas ebullition and active sheen blossoms (i.e., active surface sheening associated with ebullition) have been observed before, such as adjacent to the vertical timber pilings demarcating the location of the Siltronic outfall. Information gained during this phase of the gas ebullition monitoring program will be used to target areas for Phase 2 gas ebullition monitoring.
- **Phase 2 Gas Ebullition Monitoring:** Focused visual observations (i.e., Line of Evidence 1 described in Section 3.2.2.1.2 of the Work Plan) will be concurrently documented by video recordings (i.e., Line of Evidence 2) in areas with observations of gas ebullition and/or active sheen blossoms during Phase 1 gas ebullition monitoring program.

3.6.2 Gas Ebullition Monitoring Procedures

Sections 3.6.2.1 and 3.6.2.2 detail the procedures associated with Phases 1 and 2 gas ebullition monitoring.

3.6.2.1 Phase 1 Interim Project Area-Wide Gas Ebullition Observations

Throughout the Interim Project Area, observations will be made on 2 consecutive days before, during, and after low tide during the late summer low river elevation months using the following procedures:

- Perform visual observations within approximately 100 feet of the vessel for gas ebullition and active sheen blossoms on the surface water.
- If visual evidence of apparent gas ebullition or active sheen blossoms is observed, stop and document the following information using the Gas Ebullition Survey Visual Observations Form (Attachment A):
  - Record the time of the apparent gas ebullition and/or sheen observation.
  - Measure water depth and record on field form. Any gas bubbles or sheen produced while measuring water depth will be noted; however, these observations will not be considered gas ebullition or gas ebullition-facilitated sheen.
  - Identify the location of the apparent gas ebullition and/or sheen observation by recording position coordinates or by annotating the area on a basemap.
  - Identify the approximate dimensions of the area where apparent gas ebullition and/or sheen is observed, estimating the distance in feet (using a scale/ruler if appropriate), or if observed across a large area, sketching the area onto the basemap and referencing known landmarks.
  - Identify whether the observation is apparent gas ebullition, active sheen blossom, or static sheen (i.e., existing static sheen without a known source).
- Once apparent gas ebullition and sheen observations have been documented and recorded, return to scheduled data gaps sampling activities.

3.6.2.2 Phase 2 Focused Gas Ebullition Observations

Phase 2 focused gas ebullition observations will be made within fixed stations in areas where frequent active sheen blossoms are observed during Phase 1 observations. Up to four stations (the number of stations may be less if a relatively small area of active sheen blossoms is observed during Phase 1) within the Interim Project Area (focused outside the navigation channel) will be used as target 10-foot by 10-foot boxes for focused visual observations. In addition, tidal cycle relationships will be used to support determination of the visual observations duration.

Five-minute observation periods will be recorded within each of the identified areas following the procedures detailed herein. Video recordings will also be performed to provide further documentation of the character of sheens derived from active sheen blossoms. The following procedures will be used while observing and recording gas ebullition and active sheen blossoms during Phase 2 observations:

- If visual evidence of gas ebullition is observed, perform the following steps:

- Observe and record a description of the apparent gas ebullition frequency by counting the number of bubbles observed over a 5-minute period in an approximately 10-foot by 10-foot area. The 10-foot by 10-foot area will be demarked by first marking a 10-foot length of the railing on the boat with tape followed by extending 10-foot wood or plastic dowels from the start and end of this interval out over the river away from the railing, creating a box for visual observations. Characterize apparent gas ebullition frequency qualitatively according to the following terminology:
    - **Moderate-High Frequency:** Bubbles are observed continuously or nearly continuously with regard to time within the area apparent gas ebullition is observed (greater than 100 bubbles per minute).
    - **Low-Moderate Frequency:** Bubbles appear intermittently and/or irregularly with regard to time within the area apparent gas ebullition is observed (10 to 100 bubbles per minute).
    - **Trace-Low Frequency:** Bubbles appear but less frequently than low-moderate with regard to time within the area apparent gas ebullition is observed (less than 10 bubbles per minute).
- Characterize apparent gas ebullition spatial distribution within the gas ebullition observations area qualitatively according to the following terminology:
    - **Moderate-High Distribution:** Bubbles are widespread within the area apparent gas ebullition is observed.
    - **Low-Moderate Distribution:** Bubbles appear intermittently and/or irregularly within the area apparent gas ebullition is observed.
    - **Trace-Low Distribution:** Bubbles occur only at specific, localized points, within the area apparent gas ebullition is observed.

- Note and record environmental and anthropogenic conditions that may mimic or affect gas ebullition or may generate gas bubbles, including surface water and weather conditions at the time of the apparent gas ebullition observation (wave action and wind), presence of biota, and vessel passage or other anthropogenic factors (vessel movements, wakes, and propeller scour; anchoring; spudding; pile driving; construction; sediment sampling; and other activities that could disturb bottom sediment) that may have disturbed sediments prior to or during the visual observations.
- If a static sheen is observed or if active sheen blossoms (occurrence of a new sheen due to the migration of a drop of NAPL to the water surface, which may be due to gas ebullition from sediments) are observed, perform the following steps:
  - Observe and record static sheen and/or active sheen blossom color and appearance using the following standard terminology:

Sheen (Modified from ASTM F2534-06; sheen not observed unless noted)	
Color	**Description**
Silvery	Metallic, near transparent to silver/gray
Rainbow	Multicolored
Dark Rainbow	Multicolored with some dark metallic or brown/black coloring
Dark	Dark metallic (reflects/mirrors the color of the sky) or brown/black colored

– Observe and record sheen structure and distribution using standard terminology (see following table). Gently agitate the sheen, if possible, by moving a device (e.g., stick or rod) through the sheen. While doing so, and after removing the object, observe if the sheen rapidly coalesces as a liquid ("non-brittle sheen") or if the sheen cracks, breaks, and disaggregates ("brittle sheen") (MPCA 2017).

Sheen Structure Terminology	
Term	**Description**
Brittle	Sheen cracks and breaks apart when disturbed
Non-brittle	Sheen coalesces after being disturbed
Sheen Distribution Terminology	
Term	**Description**
Active sheen blossom	Observations of a sheen area (less than 3 feet in diameter) developing when a gas bubble breaks on the water surface
Small spots	Isolated patches (less than 3 feet in diameter) of sheen (described size and number)
Spotty	Larger areas of sheen that are comprised of many smaller patches (less than 3 feet in diameter) of sheen that may merge or separate over time (describe size and number)
Streaks	Flat lines of sheen (describe size, number, and orientation)
Contiguous	A larger patch of sheen (greater than 3 feet in diameter; describe size)

– If static sheen is observed but does not appear to be coincident with apparent gas ebullition, identify potential sheen sources if obvious.
– Record active sheen blossom frequency, if applicable, by counting and recording the number of active sheen blossoms that appear during a period in an approximately 10-foot by 10-foot area over a 5-minute time period.
– Note and record environmental and anthropogenic conditions that may affect sheen or generate gas bubbles, including surface water and weather conditions at the time of the observation (wave action and wind) and vessel passage or other anthropogenic forcing factors that may be a source of sheen to surface water.

  - Static sheen and active sheen blossoms are not observed, unless noted.
- Record the names of field personnel documenting observation of apparent gas ebullition and/or sheen in a log book and/or on the basemap.
- Record the name of the EPA field oversight personnel, if present, in a log book and/or on the basemap.
- A digital video camera will be used to record the gas ebullition observations and sheen observations within the identified 10- by 10-foot box at each observation station via the following:
  - Record the direction (e.g., north, east, or northeast) of the video and video file number on the field form.
  - Using a digital video camera, record the apparent gas ebullition and/or sheen observation. If gas ebullition is observed, record for a minimum of 120 seconds and longer as warranted based on the frequency of the gas ebullition observations.
  - Keep the video camera as still as possible to avoid blurry video.
  - At the beginning or end of recording, record the general area where the gas ebullition and/or sheen was observed, stating the area being observed and the time and date.
  - Review videos to ensure they are clear and in focus. Take additional video if needed.
- Once apparent gas ebullition, active sheen blossoms, and static sheen observations have been documented and recorded, move to the next station and repeat the 5-minute observation process. This process will be completed at the identified stations for the duration of observations on each day.
- Download electronic data (e.g., videos) from equipment prior to next use to ensure adequate backup exists.

3.7 Active Sheen Blossom Sampling

Sections 3.7.1 through 3.7.3 describe the active sheen blossom sampling procedures to be followed during the Data Gaps Investigation sampling to be performed by Anchor QEA.

3.7.1 Ebullition Sheen Sampling Plan

As described in Section 3.2.2.1.2 of the Work Plan, the intent of the ebullition sheen sampling program is to quantify gas ebullition-facilitated transport of PTW-NAPL. To achieve this objective, active sheen blossom samples will be collected at the focused (i.e., Phase 2) gas ebullition monitoring stations (Section 3.6.2.2) following active sheen blossom characterization through visual observations and video recording of a given active sheen blossom. The number and location of these Phase 2 visual observation stations will be based on field observations made during the Data Gaps Investigation sampling. NW Natural anticipates that between 5 and 10 sheen active sheen blossom samples will be opportunistically collected to cover a range of sheen colors and thicknesses and submitted for total petroleum hydrocarbons (TPH) analyses at the selected analytical laboratory.

3.7.2 Active Sheen Blossom Sampling Methods

Active sheen blossom sampling will be performed to quantify the mass of NAPL released from the sediments to surface water associated with gas ebullition. In pre-defined areas (Section 3.6), field staff will opportunistically sample active sheen blossoms that appear on the water surface by "mopping" up the pre-characterized sheen (Section 3.6) with a tetrafluoroethylene (TFE)-fluorocarbon polymer net (sheen net).

Sampling is accomplished by slowly dragging sheen nets through the target active sheen blossom over the area where sheen is observed. The sheen will be attracted and adhere to the sheen net sampler because of the sheens hydrophobic properties and thus sheens will preferentially adhere to the sheen net. When sheen nets are at maximum capacity (i.e., it is no longer capturing sheen on the net), then additional sheen nets will be used to continue sampling. Sheen sampling using TFE-fluorocarbon-coated material is described in more detail in ASTM D4489 – Standard Practices for Sampling of Waterborne Oils and in the U.S. Coast Guard *Oil Sample Handling & Transmittal Guide* (USCG 2013). Staff will be prepared to sample every day over the course of the Phase 2 visual observation period. At the end of the sampling period, the sheen net samples will be submitted to the laboratory for TPH chemical analysis that will be used to determine the mass of NAPL transported to the water surface by gas ebullition.

3.7.3 Active Sheen Blossom Sampling Procedures and Processing

Surface water sheen samples will be collected at each sampling station using a laboratory-cleaned and certified dedicated TFE-fluorocarbon polymer net (sheen net) or similar oil spill net sampling device. The following procedures will be used for surface water sheen sampling:

- After recording the characteristics identified in Section 3.6.2.2, mop up the pre-characterized active sheen blossom by slowly dragging the decontaminated dedicated sheen net through the active sheen blossom on the water surface throughout the pre-identified 10- by 10-foot box at a sampling station. Be prepared to collect additional active sheen blossoms throughout the full sampling period.
- Multiple observed active sheen blossoms within a single 10- by 10-foot observation box may be collected using the same sheen net, given all observed active sheen blossoms are initially characterized and recorded.
- Care should be taken to avoid collection of static sheen (i.e., existing surface sheen that was not observed to appear in the form of active sheen blossoms) or uncharacterized active sheen blossoms.

- At the end of the sampling period, place nets in a labeled sample jar (glass jar with Teflon-lined cap) for laboratory analysis.
- Secure the sample jar cap tightly.
- Pack the container carefully to prevent breakage and place inside a cooler with ice for storage at the proper temperature (4°C) until delivered to the project laboratory, while following the handling and chain-of-custody procedures described in Section 4.2.3. The holding times, preservation, and maximum holding times for the categories of analytes are presented in the QAPP.

The holding times, preservation, and maximum holding times for the categories of analytes are presented in the QAPP.

3.8 Biogas Generation Potential Sampling

Sections 3.8.1 through 3.8.3 describe the sampling procedures to be followed during the Data Gaps Investigation sampling to be performed by Anchor QEA to evaluate the BGP of sediments in support of gas ebullition-facilitated NAPL transport evaluations.

3.8.1 Biogas Generation Potential Sampling Plan

As described in Section 3.2.2.1.2 of the Work Plan, one of the objectives of the gas ebullition-facilitated NAPL transport evaluations is to model the subsurface biogeochemical conditions underlying the post-dredge cap to understand the likely biogas (methane and carbon dioxide) production zones and inform the potential for gas ebullition to transport NAPL under future post-construction conditions. The goal of the BGP sampling is to develop input parameters for a 1D biogeochemical reactive transport model to simulate biogas production processes in sediment as a function of depth.

To achieve this objective, 10 sample intervals from the DOC and capping demonstration subsurface sediment cores will be subsampled for laboratory characterization of labile organic carbon (LOC) pools available to bacteria for methanogenic fermentation (methanogenesis) and measurement of intrinsic BGP under laboratory conditions. The rate and total amount of biogas production is expected to be related to the abundance and lability of organic carbon present in sediment.

3.8.2 Biogas Generation Potential Sampling Methods

Samples for BGP evaluations will be collected as split samples from preselected intervals of a subset of the dredge and cap subsurface cores. The core locations and intervals were selected to represent the range of total organic carbon (TOC), total polycyclic aromatic hydrocarbon (PAH), and TPH concentrations within the area where active sheen blossoms have been observed in previous gas ebullition surveys.

A key goal of sample location selection is to include sediments containing NAPL. The locations and depth intervals were selected to include areas of potential PTW-NAPL based on the previously observed lateral extent of PTW-NAPL and previously reported TOC/PAH concentrations. The proposed sampling is anticipated to include samples with a range of NAPL concentrations.

3.8.3 Biogas Generation Potential Sampling Procedures and Processing

A split sample from each of the selected core intervals will be collected with minimal exposure to the atmosphere and transported in a cooler on ice to the Anchor QEA Environmental Geochemistry Laboratory (EGL). Upon arrival at EGL, BGP sediment samples will be logged in. The samples will be homogenized under a nitrogen atmosphere, and gravel and other debris larger than 1 cm will be removed. The homogenized samples will be stored at 4°C under nitrogen atmosphere prior to testing.

Test methods for measurement of LOC and intrinsic biogas production rates are detailed in Section 5.3.6.

3.9 Geotechnical Field Sampling

Sections 3.9.1 through 3.9.3 describes the geotechnical field program, which includes geotechnical borings and in situ penetration tests.

3.9.1 Geotechnical Sampling Plan

As described in Section 3.4.1, the intent of the subsurface geotechnical sampling program is to support the site-specific capping demonstrations and dredge prism design.

To achieve these objectives, 17 geotechnical borings and ten in situ penetration test borings will be performed at the locations shown in Figure A-11 and detailed in Table A-5. These target stations may change based on field conditions (e.g., presence of riprap, water depth, and accessibility).

Where possible, the sediment samples from the geotechnical borings will be visually inspected and logged for the presence of PTW-NAPL per the definition provided in Section 3.1. No sediment samples will be collected from the in situ penetration testing borings as they are electronic tools that do not collect physical sediment samples.

3.9.2 Geotechnical Borings

Geotechnical borings will be conducted to evaluate the geotechnical properties of sediments at the Site.

3.9.2.1 Geotechnical Boring Testing Plan

Geotechnical borings and subsurface samples will be performed and collected from 17 locations (Figure A-11 and Table A-5) using a barge-mounted sonic drill rig and drill methods in general accordance with ASTM D6914. Soil sampling and processing activities are described in Sections 3.9.2.2 and 3.9.2.3.

3.9.2.2 Geotechnical Methods

Sonic borings will start at the mudline with a 3-inch inside-diameter core sampler. The sonic core barrel sampler will be advanced into the mudline, thereby forcing the soil into the inside of the sampler's disposable, single-use plastic liner. The sampler will then be withdrawn to retrieve the liner and the sediment sample, and the liner will be cut lengthwise to remove the sediment sample. Once the top of the standard penetration test (SPT) sample interval is reached, then the split-spoon sampler will be used to perform the SPT and collect disturbed samples for testing.

Layers of fine-grained soils may be targeted for undisturbed sample collection (using a Shelby tube) if some or all of the following are noted:

- Very soft to stiff in consistency
- At least 6 inches in thickness
- In areas where caps may be placed

SPTs are proposed for each sonic boring location starting at the mudline and continuing at 5-foot or 10-foot intervals until the termination of the boring. SPTs will be performed, and the data will be used with published equations and relationships to correlate with geotechnical design parameters and approximate characteristics such as material type, undrained shear strength, compressibility, and frictional strength.

3.9.2.3 Geotechnical Sample Processing

Geotechnical sample processing will occur on the barge or on land at the project field facility.

For each core and split-spoon sample, the percent of recovery will be noted, and lithology will be interpreted in accordance with ASTM D2488 and noted on field log reports. Pictures will be taken of the recovered sediment prior to subsampling. Disturbed samples may also be collected from the core barrel liner if sample volume may be needed to supplement that which is collected in the SPT split-spoon sampler.

A minimum of one subsurface soil sample will be collected from each distinct stratum of the soil boring and placed into a labeled jar or bag, and the sample intervals will be noted on the boring logs. The volume of soil collected will be dependent on the anticipated laboratory test to be assigned. No logging will be done on Shelby tubes, and the tube samples will be capped and the ends sealed.

The filled sample jars or bags and sealed Shelby tubes will be stored at room temperature until delivery to the geotechnical laboratory. The Shelby tubes will be extruded, and samples will be trimmed for testing by the geotechnical test laboratory. Sample handling and transport will be in accordance with ASTM D4220.

Laboratory test assignments will be determined by the field coordinator in consultation with the project geotechnical engineer based on the encountered sediment types. Assignments will be based on sample type (disturbed or undisturbed), soil type (fine grained or coarse grained), and observed lithology. One-dimensional consolidation, direct shear strength, and triaxial shear strength testing will only be performed on undisturbed samples.

3.9.3 In Situ Penetration Testing

In situ penetration testing will be conducted to evaluate the geotechnical properties of sediments and soils at the Site.

3.9.3.1 In Situ Penetration Testing Plan

Cone penetration test with pore pressure measurement (CPTu) and full-flow penetration (FFP) tests will be performed on sediments within the Interim Project Area to collect geotechnical information that will support the objectives noted in Section 3.4.1. In situ penetration tests for the geotechnical program will be conducted at the nine locations shown in Figure A-11.

In situ penetration tests will be advanced to specified depths as presented in Table A-5 unless refusal or equipment limitations are encountered at shallower depths. Up to two attempts will be made at each location. If the first attempt does not yield an acceptable penetration depth, an additional attempt will be made within 50 feet of the original location.

Pore pressure dissipation testing will be conducted at 2.5- to 5.0-foot intervals within the upper 20 feet of sediment during the CPTu testing.

3.9.3.2 In Situ Penetration Testing Methods

The CPTu and FFP are hydraulically pushed probes that collect data continuously as the probe is pushed through the sediment. General testing procedures for CPTu are outlined in ASTM D5778, Lunne et al. (1997), *International Reference Test Procedure for Cone Penetration Test* (ISSMFE 1999), and other guidelines. The FFP testing procedure is the same as the CPTu except for the probe shape (a cone for CPTu versus a sphere or t-bar for FFP), which allows for extra sensitivity when measuring low-strength sediments. CPTu and FFP tests will be performed from a barge-mounted direct-push drill rig.

Data are transmitted from the probe through cable connections or wireless connection to a data collection system for review by the operator. Use of these in situ tests are advantageous at this phase for the following reasons:

- They provide a continuous, high-resolution stratigraphic profile through the tested sediment column.
- Probes can penetrate and test through most of the range of consistency/density of sediment and native material (very soft/loose to hard/dense soils).
- Reliable equations and relationships have been developed to correlate collected data with geotechnical design parameters, such as material type, undrained shear strength, and frictional strength, without physically collecting samples or performing laboratory tests.
- Probes are easily interchangeable in the field.
- Various probes use the same rods, attachments, and data collection system (modular).
- Because physical samples are not obtained using CPTu or FFP, sediment and soil IDW management and disposal is unnecessary. Other IDW will be managed according to Section 4.4.1.

An FFP probe will be used for the upper meter of sediment. A CPTu probe will replace the FFP probe to complete the remainder of the push at each in situ penetration location.

3.9.3.3 In Situ Penetration Testing Data Management Procedures

In situ penetration testing using CPTu and FFP probes will not recover samples; however, field notes will be recorded, and photographs will be taken of any significant observations made during testing. Data collection and data reduction will be performed by the CPTu/FFP subcontractor, and a final data report will be provided for use. Preliminary geotechnical design parameters will be interpreted by the project geotechnical engineer.

3.10 Summary of Sampling Intervals for All Programs

The sampling intervals for all programs (i.e., the various surface, subsurface, riverbank, and geotechnical sample intervals at each location) are summarized in Table A-6.

3.11 Horizontal Positioning and Vertical Control

Horizontal positioning at each sampling location will be determined using a DGPS with a handheld GPS unit as backup if necessary. All vertical geographical coordinates will be relative to the City of Portland datum (COP), and horizontal geographical coordinates will be in the North American Datum of 1983 (NAD83) High Accuracy Reference Network 91 (HARN91), Oregon State Plane, North Zone, in international feet.

Mudline elevations of each sediment sampling location will be determined relative to COP by measuring the water depth with a calibrated fathometer or lead line and subtracting the tidal elevation. River elevations will be determined using the on-site river gauge transducer installed on the PacTerm dock.

Depths associated with the top of riverbank angled sonic borings will be recorded in field documentation as depth below ground surface. The elevation of ground surface at each boring location will be surveyed following completion of soil boring installation activities, prior to the replacement of any erosion protection material.

3.12 Field Quality Assurance/Quality Control Samples

Field QA/QC samples will be collected and used to evaluate the variability resulting from sample handling and the efficiency of field decontamination procedures (Section 4.3). All field QC samples will be documented in the Site log book.

3.12.1 Field Duplicates

Field duplicates (i.e., homogenization duplicates) will be collected at a frequency of one per 20 samples. The field duplicates will be prepared by dividing aliquots of the homogenate (during grab, core, or boring processing and/or field collection) into two distinct samples for the laboratory (the original sample and a duplicate). The samples will be processed in the same way as the original sample and will be submitted to the laboratory as blind samples. The duplicate samples will be analyzed for the full suite of bulk sediment and soil testing listed in the QAPP. This type of field QA/QC sampling is not applicable to VOCs given sampling for these chemicals does not include homogenization of the sample volume. Field duplicates for VOCs will be collected by taking additional samples as close to the original sample as possible. Field duplicate sample identification procedures are described in Section 3.12.

3.12.2 Field Blanks

Field blank samples will be collected to evaluate the efficiency of field decontamination procedures. One rinsate blank and one field blank will be collected weekly for each type of sampling technique used. The rinsate blank will consist of rinsing down the sediment grab, coring, boring, and homogenization equipment after sample collection and decontamination and collecting the rinsate. The field blank will be collected by pouring distilled water directly in the sampling containers. In addition, a trip blank will be included in each container shipped to the analytical laboratory containing samples to be analyzed for volatiles (i.e., VOCs). The field blank samples will be analyzed for all chemicals within a given sampling program. Rinsate blank and field duplicate sample identification procedures are described in Section 3.12.

3.13 Location and Sample Identification

Each discrete sediment sample will be assigned a unique alphanumeric identifier according to the method described in this section. The identifiers facilitate sample tracking by incorporating identifying information. The alphanumeric identifiers will be assigned for sediments and soils as described in Sections 3.12.1 and 3.12.2.

3.13.1 Sample Identification

The alphanumeric identifiers will be assigned in the following manner for surface sediment grab samples:

- The first three characters for the in-water locations identify the sample location by the project descriptor: PDI = Pre-design Investigation.
- The next two characters identify the sample location: 01 = Location 01.
- The next two to six characters identify the sampling matrix:
  - SG = Surface Sediment Grab (A, B, and C suffixes will be applied to subsample locations)
  - DSG = Depositional Sediment Grab
  - RAB = Riverbank Angled Boring
  - SC = Sediment Core
  - JTNAPL = Extracted NAPL
  - PW = Porewater
  - ASB = Active Sheen Blossom
  - NAPL = NAPL Mobility Core
  - SPT = Standard Penetration Test Geotechnical Boring
  - IP = In Situ Penetration Test
- The next two characters identify the subsurface sampling interval in feet below ground surface, though not applicable to surface sediment grab samples, active sheen blossoms, or in situ penetration tests.
- The next six characters identify the collection date: YYMMDD.

Examples:

1. Sample number PDI-02SG-191101 indicates a sediment grab sample obtained from Location 02 on November 1, 2019.
2. Sample number PDI-17DSG-191104 indicates a depositional sediment grab sample obtained from Location 17 on November 4, 2019.
3. Sample number PDI-08RAB-4-5-191115 indicates a riverbank angled boring sample obtained from Location 08 and collected at a depth of 4 to 5 feet bml on November 15, 2019.

4. Sample number PDI-15SC-4-8-191110 indicates a sediment core sample obtained from Location 15 and collected at a depth of 4 to 8 feet bml on November 10, 2019.
5. Sample number PDI-10JTNAPL-1-3-191114 indicates an NAPL sample extracted via shake test obtained from Location 10 and collected at a depth of 1 to 3 feet bml on November 14, 2019.
6. Sample number PDI-34PW-4-6-191117 indicates a porewater sample obtained from Location 34 and collected at a depth of 4 to 6 feet bml on November 17, 2019.
7. Sample number PDI-06ASB-181106 indicates an active sheen blossom sample at Location 06 obtained on November 6, 2018.
8. Sample number PDI-07NAPL-2-6-191109 indicates a NAPL mobility core sample obtained from Location 07 and collected at a depth of 2 to 6 feet bml on November 9, 2019.
9. Sample number PDI-03SPT-2-3.5-191101 indicates a standard penetration test geotechnical sample obtained from Location 03 and collected at a depth of 2 to 3.5 feet bml on November 1, 2019.
10. Sample number PDI-11IP-191115 indicates an in situ penetration test performed at Location 11 on November 15, 2019.

The sampling depth intervals will also be noted in the field logs and provided in the chemical analytical results tables.

3.13.2 Field Quality Assurance/Quality Control Sample Identification

The field QA/QC samples will be assigned a unique alphanumeric identifier according to the following method:

- The first three characters identify the sample location by using the first letter of each word in the location name: PDI = Pre-Design Investigation
- The rinsate blank samples will be followed with an -RB and a two-letter identifier for the sample collection technique (SG for sediment grab, SC for sediment core, AB for riverbank angled boring, and PW for porewater) followed by the date in YYMMDD format.
- The field blank samples will be followed with an –FB (SG for sediment grab, SC for sediment core, AB for riverbank angled boring, and PW for porewater) followed by the date in YYMMDD format.
- The homogenization duplicate will be followed with –XXXSG-YYMMDD (surface sediments) where XXX is the location number plus 1000 and YYMMDD is the sampling date.

For example, sample number PDI-RB(FB)SG-191101 and PDI-1001SG-191101 represent a sediment grab rinsate blank (field blank) collected on November 1, 2019, and a homogenization duplicate collected from sediment grab sample Location 01 on November 1, 2019, respectively.

4 Field Documentation, Sample Handling, Decontamination Procedures, and Investigation-Derived Waste Management

Consistent methods of field documentation, sample handling, equipment decontamination, and IDW management will be used throughout the program.

4.1 Field Documentation

A complete record of all field activities will be maintained, including the following:

- Documentation of all field activities in field log books
- Documentation of all samples collected for analysis

The field staff will maintain the field log books, which will consist of bound, numbered pages. All on-site activities, including health and safety entries, and field observations will be documented in these log books. All entries will be made in indelible ink. The field log books are intended to provide sufficient data and observations to enable readers to reconstruct events that occurred during the sampling period. The field log books will include clear information concerning any modifications to the details and procedures identified in this FSP. Surface sediment sample, sediment core, gas ebullition observation, porewater collection, and soil boring collection log sheets will be completed for each sampling location (sample log sheets are presented in Attachment A).

Logs and field notes of all samples will be maintained as samples are collected and correlated to the sampling location map. The following information will be included as part of this documentation:

- Percent recovery and factors used to determine the recovery (for cores)
- Coordinates of each location as determined by DGPS
- Date and time of collection of each sample
- Names of field supervisor and personnel collecting and logging in the sample
- Observations made during sample collection, including presence of PTW-NAPL per the site-specific definition provided in Section 3.1, weather conditions, complications, ship traffic, and other details associated with the sampling effort
- Sample location number
- Length and depth intervals of each core/boring section
- Qualitative notation of apparent resistance of sediment/soil column when coring/boring
- Any deviation from the approved Work Plan and FSP

4.2 Sample Handling

This section describes the sample containers, sample handling and storage, chain-of-custody forms, and sample shipping for all sediment sampling activities.

4.2.1 Sample Containers for Analysis

All sample containers received from the analytical laboratory will be pre-cleaned and certified. Prior to shipping, the analytical laboratory will add preservative, where required. Sample container types are listed in Table A-7.

Prior to filling, each container will be clearly labeled with the name of the project, sample number, type of analysis, date, time, and initials of the person preparing the sample.

4.2.2 General Sample Handling and Storage

The guidelines for sample handling and storage for collected samples are provided in Table A-7. Sample containers, instruments, working surfaces, technician protective gear, and other items that may come into contact with environmental media must meet high standards of cleanliness. All equipment and instruments used to remove sediment from the sampler will be made of glass, stainless steel, or polytetrafluoroethylene (PTFE) and will be decontaminated prior to each day's use and between sampling or homogenization events.

All working surfaces and instruments will be thoroughly cleaned, decontaminated (following the protocols in Section 4.3), and covered with tinfoil to minimize outside contamination between sampling events. Disposable gloves will be discarded after processing each location and replaced prior to handling decontaminated instruments or work surfaces. Sample containers will be kept in packaging as received from the analytical laboratory until use; a sample container will be withdrawn only when a sample is to be collected and returned to a cooler containing completed samples.

4.2.3 Sample Transport and Chain-of-Custody Procedures

All containerized samples will be delivered to the designated analytical laboratories by courier after preparation is completed. Specific sample shipping procedures will be as follows:

- The shipping containers will be clearly labeled with sufficient information (name of project, time and date container was sealed, person sealing the container, and consultant's office name and address) to enable positive identification.
- Individual sample containers will be placed in a sealable plastic bag, packed to prevent breakage, and transported in a sealed ice chest or other suitable container.
- Glass jars will be separated in the shipping container by shock absorbent material (e.g., bubble wrap) to prevent breakage.
- Ice (in separate, sealed plastic bags) will be placed in the cooler to maintain a storage temperature of approximately 4°C.
- A sealed envelope containing chain-of-custody forms will be enclosed in a plastic bag and taped to the inside lid of the cooler.
- The cooler lids will be secured by wrapping the coolers in strapping tape.

- Signed and dated chain-of-custody seals will be placed on all coolers prior to shipping.
- Each cooler or container containing the sediment and soil samples for analysis will be picked up at the Gasco facility by courier daily.

Upon transfer of sample possession to the analytical laboratory, the persons transferring custody of the sample container will sign the chain-of-custody form. Upon receipt of samples at the laboratory, the shipping container seal will be broken, and the receiver will record the temperature and condition of the samples and cross-check the sample inventory with the chain-of-custody form. Chain-of-custody forms will be used internally in the laboratory to track sample handling and final disposition.

4.3 Field Equipment Decontamination

To prevent sample cross contamination, sampling and processing equipment in contact with the environmental media will undergo the following decontamination procedures prior to and between collection activities in accordance with EPA protocols (EPA 2001). Between samples, all sampling equipment that will come in contact with the sample media will be decontaminated prior to use by the following procedures:

- Rinse with river water and wash with a scrub brush until free of sediment.
- Wash with phosphate-free detergent (e.g., Alconox).
- Visually inspect the sampler and repeat the rinse and scrub step, if necessary. If scrubbing and rinsing with Alconox is insufficient to remove visually observable tar/oil-related contamination on sampling equipment, the equipment will be scrubbed and rinsed using acetone (or similar type solution) until all visual signs of contamination are absent.
- Rinse with deionized water three times.

All sample homogenizing equipment (e.g., spoons and bowls) will be decontaminated prior to and between processing cores/borings at each location using the same procedures detailed in this section.

4.4 Management of Investigation-Derived Waste and Surface Water Sheens

Information regarding the management of IDW and incidental surface water sheens produced during sampling are detailed in Sections 4.4.1 and 4.4.2.

4.4.1 Management of Investigation-Derived Waste

IDW, including excess sediments remaining following chemical and physical subsampling, purge water, fluids used for decontamination of sampling equipment, and disposable wastes (e.g., gloves, paper towels, and foil) will be placed into appropriate containers and staged on-site for disposal.

Consistent with the *Portland Harbor Pre-Remedial Design Investigation and Baseline Sampling Surface Sediment Field Sampling Plan* (AECOM and Geosyntec 2018a), excess surface sediments will not be IDW and returned to the river at the approximate sampling location if the sediments do not contain visible sheens or PTW-NAPL.

Sediments and soil remaining after collection and processing will be placed into sealable containers (55-gallon open-top drums). Disposable wastes will be placed into two heavy-duty plastic bags (i.e., double-bagged). All solid waste will be disposed off site at an appropriate Resource Conservation and Recovery Act (RCRA)-permitted solid waste disposal facility.

Per the current IDW Management Plan (HAI 2008) for the Site and follow-up communication from DEQ (DEQ 2010), sediment and soil IDW will be characterized by collecting and analyzing one five-part composite sample per drop box and one composite sample per every five to ten 55-gallon drums. Samples will be tested for the following Site COCs and whether the waste is characteristically hazardous (ignitable, reactive, or corrosive):

- Free liquids
- VOCs
- Diesel- and oil-range hydrocarbons
- Gasoline-range hydrocarbons
- RCRA eight metals (total)
- Total cyanide
- PAHs
- Ignitability
- Corrosivity

All sediment and soil IDW will be screened to determine suitable waste disposal options. In addition, sediment and soil IDW generated will be screened against F002 Threshold Screening Values, DEQ's most current risk-based concentrations (RBCs) for human health occupational exposure pathway for F002-related constituents, in order to determine whether the waste will need to be handled as an F002-listed RCRA (Pearl Legal Group 2018). The IDW Management Plan (HAI 2008) identifies the following chemicals as F002-related constituents:

- Trichloroethene (TCE)
- Cis-1,2-dichloroethene
- Trans-1,2-dichloroethene
- 1,1-dichloroethene
- Vinyl chloride

After laboratory results have been compiled and screened as required, NW Natural will prepare a letter of intent to dispose IDW, which will be submitted to DEQ for review. The request to DEQ will include laboratory testing results, screening results, and the proposed final disposition of the waste. Upon DEQ approval of the proposed final waste disposition, a waste profile will be submitted to the selected disposal facility requesting acceptance of the waste for the disposal. Upon acceptance by the disposal facility, waste will be transported from the site to the facility by a selected licensed contractor.

The decontamination fluids and other water generated during the investigation will be stored in sealable containers and disposed on site at the Siltronic pretreatment facility, which is part of the Gasco Groundwater Treatment System.

4.4.2 Management of Surface Water Sheens

There is potential for surface water sheens to develop while implementing the Data Gaps Investigation sampling. Sheens observed may be the result of natural processes or investigation methods. To ensure that any sheen observed is managed appropriately, the following protocols will be followed:

- Sheens resulting from the disturbance of sediments during the Data Gaps Investigation will be handled using the following procedures:
  - Sorbent booms will be deployed to capture any significant sheen observed on the water surface during sediment grab or subsurface core collection.
  - If necessary, the sorbent booms will be deployed/managed by a small support vessel to allow the sampling vessel to operate without interruption.
  - Depending on the size of the sheen observed, the National Response Center (800-424-8802) will be contacted to advise on additional mitigation measures and appropriate agency notifications, if necessary. The EPA project manager will also be notified under this scenario.
- Sheens observed during gas ebullition monitoring and sheen sampling (Sections 3.6 and 3.7) that did not result from the disturbance of sediments will not be managed.

5 Chemical and Physical Testing

This section summarizes the target physical and chemical analyses for the various media sampled. Sample analyses will be conducted in accordance with EPA-approved methods (where available) and the QAPP (Appendix B of the Work Plan). Prior to analysis, all samples will be maintained according to the appropriate holding times and temperatures for each analysis (Table A-7). Chemical and physical testing analytes are summarized in Table A-8. The methods for each of the chemical and physical analyses are described in the QAPP.

Prior to the chemical analysis of the samples, the laboratories will calculate method detection limits for each analyte of interest, where applicable. Method detection limits will be below the values specified in the QAPP if technically feasible. To achieve the required detection limits, some modifications to the specified analytical methods may be necessary. These modifications will be provided by the laboratories at the time of establishing the laboratory contract.

Sediment, soil, and porewater chemical and physical testing will be conducted at Apex Laboratories in Tigard, Oregon. Apex Laboratories is accredited under the National Environmental Laboratories Accreditation Program. Disposal suitability and barge dewatering (dredge elutriate) testing will be performed by Waste Stream Technology in Niagara Falls, New York. NAPL core processing and mobility testing will be conducted by Core Laboratories. Geotechnical testing will be conducted at NW Geotech in Wilsonville, Oregon. Samples submitted for comprehensive hydrocarbon analysis will be submitted to Alpha Analytical Laboratories in Mansfield, Massachusetts. All chemical and physical testing will adhere to SW-846 QA/QC procedures and analysis protocols (EPA 1986, 1992, 1993, 1994, 1995) or follow the appropriate ASTM or standard method. All the analytical laboratories will prepare detailed reports in accordance with the QAPP.

Sediment, soil, porewater, NAPL, sheen, and geotechnical samples will be submitted for a variety of tests prepared by different methods including bulk chemistry, physical parameters, geotechnical parameters, dredge elutriate testing, sequential batch leach test, and toxicity characteristic leaching procedure (TCLP) analysis. Sections 5.1 through 5.6 discuss the testing associated with each environmental medium in more detail by sample type. Analytical methods and QA/QC requirements are discussed in the QAPP. The anticipated sampling intervals for the chemical and physical testing are shown in Tables A-4 and A-5.

Note that polychlorinated biphenyl (PCB) congeners will be analyzed for all surface sediment samples (0 to 1 foot), and PCB Aroclors will be analyzed for all DOC and additional analysis subsurface samples and riverbank soil samples.

5.1 Surface Sediment

Details regarding the sampling schemes for surface sediment and depositional sediment are presented in this section.

5.1.1 Surface Sediment Grab Sampling

Surface sediment grab samples collected for Interim Project Area refinement and additional surface sediment data density will be submitted for the following analyses:

- ROD Table 21 COCs with RALs and highly toxic PTW thresholds
  - As described in Section 3.1 of the TEWP (Anchor QEA 2019a), chlorobenzene will not be analyzed because the threshold value was developed for the ROD (EPA 2017) based on feasibility-level harborwide assumptions that are not applicable at the Site. NW Natural is performing a site-specific capping demonstration evaluation to determine if any of the ROD Table 17 COCs containing groundwater cleanup levels (CULs) cannot be reliably contained. The samples will be analyzed for PCB congeners.
- TOC and total solids (TS), and grain size

The depositional sediment grab samples will be submitted for the following analyses:

- ROD Table 21 COCs with RALs and highly toxic PTW thresholds
  - As described in Section 3.1 of the TEWP, chlorobenzene will not be analyzed because the threshold value was developed for the ROD based on feasibility-level harborwide assumptions that are not applicable at the Site. NW Natural is performing a site-specific capping demonstration evaluation to determine if any of the ROD Table 17 COCs containing groundwater CULs cannot be reliably contained. The samples will be analyzed for PCB congeners.
- ROD Table 17 COCs with riverbank soil/sediment CULs including pesticides by high resolution gas chromatography/mass spectrometry EPA Method 1699 to attempt to achieve detection limits below the CULs
  - The samples will be analyzed for PCB congeners.
- TOC, TS, and grain size

5.2 Riverbank Angled Borings

Riverbank angled boring samples will be submitted for the following analyses:

- ROD Table 21 COCs with RALs and highly toxic PTW thresholds
  - As described in Section 3.1 of the TEWP, chlorobenzene will not be analyzed because the threshold value was developed for the ROD based on feasibility-level harborwide assumptions that are not applicable at the Site. NW Natural is performing a site-specific capping demonstration evaluation to determine if any of the ROD Table 17 COCs

containing groundwater CULs cannot be reliably contained. The samples will be analyzed for PCB congeners.

- Analytes with a ROD Table 17 riverbank soil/sediment CUL
- Analytes with a ROD Table 17 groundwater CUL
- TOC and TS
- Bulk density, moisture content, grain size, and specific gravity
  - These will be analyzed on 20% to 30% of the riverbank angled boring samples and will be determined in the field.

5.3 Subsurface Sediment

Eight different chemical and physical testing programs will be addressed through the collection of subsurface sediment cores. Details regarding the sampling scheme for each of the testing programs are presented in this section. At many core locations, multiple chemical testing programs are being applied. Table A-4 identifies the different sampling intervals and programs associated with each core.

TOC and TS will be analyzed in all subsurface sediment samples regardless of program. Geotechnical parameters (Atterberg Limits, moisture content, grain size, and specific gravity) will be analyzed in a small percentage (not more than 20%) of the subsurface sediment samples. The density and number of geotechnical parameters may be revised based on field lithology.

More information about the chemical and physical testing for the different testing programs can be found in Sections 5.3.1 through 5.3.8.

5.3.1 Depth of Contamination Testing

Sediment cores samples for DOC identification will be collected and analyzed using the following protocols:

- The first samples analyzed from each DOC core will be the bottom two whole 1-foot intervals (e.g., 12 to 13 feet and 13 to 14 feet). These samples will be analyzed for ROD Table 21 COCs with RALs and PTW-highly toxic thresholds. If there is a fraction of a foot greater than 0.5 feet (e.g., core recovery of 14.8 feet) below the bottom whole 1-foot interval collected for analysis, then an archive sample will be collected of this material. If the fraction of a foot is less than 0.5 feet (e.g., core recovery of 14.3 feet) below the bottom whole 1-foot interval collected for analysis, then, due to sample volume requirements, no archive will be collected.
- Subsamples overlying the bottom 2 feet will be collected at 1-foot intervals to the top of the core and archived for future analysis of ROD Table 21 COCs with RALs and PTW-highly toxic threshold pending the results from intervals below.
- If either of the bottom two samples exceeds ROD Table 21 RALs and PTW-highly toxic thresholds, the DOC will be considered unbounded.

- If both the bottom two 1-foot intervals do not exceed ROD Table 21 RALs and highly toxic PTW threshold, the overlying next two 1-foot sample intervals will be removed from archive and analyzed for ROD Table 21 COCs with RALs and PTW-highly toxic threshold.
- The analysis of archived samples will continue in groups of two (two 1-foot intervals) until a sample interval shows concentrations of COCs above ROD Table 21 RALs and PTW-highly toxic threshold. The deepest interval with COC concentrations above ROD Table 21 RALs and PTW-highly toxic threshold will be designated the DOC.

5.3.2 Cap Model Testing

Sediment cores samples for cap modelling analyses will be collected and analyzed using the following protocols:

Nearshore ROD-Identified Capping Area Locations

- Sampling will start at the mudline.
- Samples will be collected and analyzed for PAHs (the full suite of PAHs will be analyzed to achieve a total PAH sum), VOCs, and arsenic on alternating 2- and 3-foot intervals from the mudline to 10 feet bml (i.e., 0 to 2 feet, 2 to 5 feet, 5 to 7 feet, and 7 to 10 feet) and from 10 to 13 feet bml.
- For samples from 13 feet bml to the bottom of the recovered core depth, material will be archived at 2-foot intervals. If the last interval is less than 1 foot thick, it will be merged with the interval above (e.g., 13 to 15.3 feet).
- Intervals that completely overlap with analyzed DOC core intervals will not be run for PAHs to prevent the collection of redundant data.

Offshore ROD-Identified Capping Area Locations

- Sampling will start at the mudline.
- Samples will be collected and analyzed for the PAHs (the full suite of PAHs will be analyzed to achieve a total PAH sum), VOCs, and arsenic at 2-foot intervals from the mudline to 10 feet bml. An additional 3-foot sample will be collected from 10 to 13 feet bml.
- From 13 feet bml to the bottom of the core, material will be archived at 2-foot intervals. If the last interval is less than 1 foot thick, it will be merged with the interval above.
- Intervals that completely overlap with analyzed DOC core intervals will not be run for PAHs to prevent the collection of redundant data.

Nearshore and Offshore ROD-Identified PTW-NAPL Areas

- Sampling will start at the mudline.
- Nearshore and offshore sediment core samples will be collected and analyzed for PAHs (the full suite of PAHs will be analyzed to achieve a total PAH sum), VOCs, and arsenic on intervals

identical to the nearshore and offshore ROD-identified capping locations previously presented in this section. If PTW-NAPL is identified during core processing, it will be recorded and assessed for further analysis in the context of NAPL mobility testing program detailed in Sections 3.4.4 and 5.3.5.

5.3.3 Dredge Material Disposal Suitability

Samples for waste characterization and disposal suitability testing will be collected and analyzed using the following protocols:

- Sampling will start at the mudline and extend to the field-estimated DOC based on visual and olfactory indications of contamination. This entire depth of sediment will be vertically composited and homogenized to create a single sample.
- Bulk sediment samples will be collected and analyzed for the following:
  - RCRA waste characteristics of ignitability and corrosivity using test methods ASTM D93, SW-846, and EPA 9045D, respectively
  - F002 wastes (TCE, cis-DCE, trans-DCE, 1,1-DCE, and vinyl chloride)
  - TCLP analytes (RCRA eight metals, VOCs, semivolatile organic compound [SVOCs], pesticides, and herbicides)

5.3.3.1 Toxicity Characteristic Leaching Procedure Testing

TCLP testing will follow SW-846 test method 1311, which involves tumbling a specified volume of sediment or soil in a buffered extraction fluid to generate a simulated leachate, which is then analyzed for organic and inorganic constituents specified in the regulations (EPA 1993).

A separate aliquot for volatiles analysis is required; however, this aliquot will be collected after homogenization to mimic the conditions that would occur during sediment removal (e.g., mixing and air exposure).

Initially, the TCLP samples will be run without any dewatering amendments added. If the TCLP concentrations are less than the TCLP criteria, no additional TCLP testing will be performed. If these samples exceed the TCLP criteria, TCLP tests will be performed on sediment samples that have been amended and cured using the optimized sediment stabilization process, as described in Section 5.3.3.2).

5.3.3.2 Dredge Material Disposal Suitability Testing

For any unamended samples that fail the disposal suitability criteria (i.e., RCRA, F002, TCLP, and RBC), the samples will be stabilized with amendments and re-tested for the failed disposal suitability criteria. Stabilization will be performed using a variety of amendment types and dosages. Several amendments will be evaluated using a minimum of three dosage ratios per amendment. Optimum dosage ratios will be evaluated through paint filter testing, percent solids analysis, and visual observations of physical characteristics (e.g., flocculation or coagulant formation, rapid separation of solids and liquid release, and clarity) at specified cure periods (e.g., 24 hours, 48 hours, and 72 hours). Dosage ratios will also be monitored for weight change.

The following amendment types may be tested to determine their suitability for stabilizing the dredged sediments:

- Type I Portland cement
- Calciment
- Lime kiln dust

Based on the results of the bench scale treatability testing performed during the early removal action characterization, it is anticipated that each of these amendments will be added to the test sediments using between 5% to 15% by weight. The goal is to determine the most optimum combination of amendment, dosage ratio, and cure time to allow the stabilized end product to pass the paint filter test and meet the minimum structural strength required by the disposal facility. Amendments to be used will be provided by the manufacturer based on what is anticipated to be readily available for full-scale application during construction of the final remedy. Manufacturer-provided specification sheets will be included in the final treatability test report. A pocket penetrometer will be used to evaluate the strength of the amended sediments, and the moisture content of the amended samples will also be analyzed.

At locations that failed the TCLP screening, detailed in Section 5.3.3.1, additional TCLP analyses will be performed on a composited, homogenized archived sediment sample from that location. The archive sample will be stabilized using the optimized amendment and dosage identified at that location.

Upon opening of the archived sample volume containers (anticipated to be a 5-gallon bucket for non-volatile compounds and a zero-headspace container for volatile compounds analyses), any standing water in each container will be mixed into the sediment using either a spoon or hand drill with mixer paddle attachment. The mixed sediment will then be weighed out separately for the non-volatile and volatile containers, and the appropriate amount by weight of admixture will be added and mixed separately into these containers.

TCLP testing will be conducted separately on the resulting non-volatile and volatile sediment-admixture sample following the methods described in Appendix D of the *Evaluation of Dredged Material Proposed for Disposal at Island, Nearshore, or Upland Confined Disposal Facilities – Testing Manual (*USACE 2003). Additional testing to determine the ability to remove free liquid or meet bearing strength requirements of potential disposal facilities may also be performed on the mixed sediment.

5.3.4 Dredge Material Haul Barge Dewatering (Dredge Elutriate Testing)

To estimate the chemical concentrations of excess water in the dredge material haul barge in contact with dredge sediments and support water quality treatment evaluations based on these concentrations, dredge elutriate tests will be conducted using the following protocols (the method is a modified version of ASTM D6586):

- Consistent with and co-located with the dredge material disposal suitability testing in Section 5.3.3, sampling will start at the mudline and extend to the field-estimated DOC based on visual and olfactory indications of contamination. This entire depth of sediment will be vertically composited and homogenized to create a single sample.
- River water will be collected approximately 3 feet above the mudline at each station. Pending EPA review and approval, river water may alternatively be collected at a single location approximately 3 feet above the mudline at the approximate center point of the proposed dredge material haul barge dewatering locations. This alternative sampling approach would save considerable sampling time while still achieving the data quality objectives for the dredge elutriate testing.
- The composited, homogenized sediment samples and river water will be sent to the Waste Stream Technology laboratory for dredge elutriate analyses of cyanide, metals, PCBs, Pesticides, PAHs, SVOCs, VOCs, pH, and total suspended solids (TSS).

Dredge elutriate testing involves mixing site sediment and site water in a specified ratio, followed by agitation of the slurry mixture for a specified period, settling or filtration of solids, and analysis of the resulting water column. Standard elutriate tests will be conducted in accordance with national dredged material disposal guidelines (EPA and USACE 1991).

The standard elutriate test procedure is as follows:

- Site sediment and river water are mixed in the laboratory at a 1:4 sediment-to-water ratio, by volume.
- The sediment-water mixture is vigorously agitated for 30 minutes, then allowed to settle for 1 hour.
- A sample of the supernatant is siphoned off the water column.
- Sufficient elutriate water will be withdrawn to prepare both unfiltered (total) and filtered (dissolved) samples (only unfiltered samples for TSS); the untreated total and dissolved fractions will be submitted to the analytical laboratory for initial chemical analyses.

Based on the initial untreated dredged material elutriate concentrations, the elutriate will be treated through the following series of steps to optimize a cost-effective water treatment process for those constituents that require treatment prior to discharge:

- Prepare four separate 1-liter decanted elutriate samples.

- Use polymer cup tests to establish an optimal polymer dosage.
- Dose the samples with four different dosages of ferric sulfate solution: 20 milligrams per liter (mg/L), 40 mg/L, 60 mg/L, and 80 mg/L; the range of anticipated dosages is based on experience at other sites.
- Apply the optimal polymer dosage to each of the four elutriate samples.
- Filter all samples through 1-micron filters and analyze for total and dissolved metals on a 1-day turnaround time.
- Retain the remainder of the filtered samples.
- Using the best results, pump the flow through specially configured pipettes containing granular activated carbon (GAC) in a procedure known as the rapid, small-scale column test, which is a method developed by Sevenson based on ASTM D6586 to establish the performance of GAC on dissolved organic contaminant COCs (ASTM 2014).
- Treatment processes will be identified based on percent reduction.

5.3.5 NAPL Mobility Testing

The sediment cores collected for NAPL mobility testing will be shipped to Core Laboratories using the processes detailed in Section 3.4.4. At Core Laboratories, the cores collected for mobility testing will be analyzed using the following protocols:

- Core samples will be cut axially (slabbed) and photographed under white and ultraviolet light.
- Photographs of the slabbed core will be reviewed, and the intervals with the most notable NAPL will be selected for testing.
- Selected intervals will undergo NAPL mobility testing via centrifuge.

Under the centrifuge testing procedure, the sediment core sample will be subjected to hydraulic gradients 25 times stronger than those that exist in situ to force NAPL to flow from the sample (i.e., 25 times the force of gravity). The volume of NAPL drained from the soil core sample will be quantified, in addition to the final NAPL mass remaining in the sample. These data will be used to calculate the initial NAPL saturation in the sample.

Pending the results of the centrifuge test, additional parameters will be measured as part of the NAPL mobility testing process. These additional parameters include percent water saturation, hydraulic conductivity, percent initial and final NAPL saturation, capillary pressure, total porosity, grain density, and dry bulk density. At the completion of the NAPL mobility testing, grain size will be analyzed. In addition, testing will be conducted for select depth intervals within the NAPL mobility cores to characterize sediment properties that may affect NAPL and dissolved-phase transport. The additional tests may include porosity, bulk density, TOC, vertical permeability, capillary pressure curve analysis, and grain size analysis. Sample intervals selected for these additional analyses may include relatively coarse-grained layers and fine-grained layers, including the interpreted capillary barrier layers above NAPL-containing zones, which could impede upward NAPL migration.

5.3.6 Biogas Generation Potential Testing

Proposed BGP samples located in the Shallow Region (EPA 2017) will be analyzed from 5 to 7 feet bml, and proposed BGP samples located in the Intermediate Region will be analyzed from 6 to 8 feet. The sediment sample intervals for the BGP evaluations will be tested for the following:

- TOC
- PAH
- TPH
- Chemical oxygen demand (COD)
- LOC fractions
- Intrinsic biogas production potential
- Moisture content
- Grain size

TOC, PAH, and TPH concentrations will be obtained from the analysis of the core interval split used for DOC evaluations. For the BGP sample intervals, both parent and alkyl PAHs will be analyzed. The remaining tests will be performed on the homogenized BGP sample split.

LOC will be determined using the method of Rovira and Vallejo (2002).

Intrinsic biogas production potential of BGP samples will be measured using a modified batch anaerobic incubation method based on Esposito et al. (2012). Briefly, sediment microcosm reactors will be set up and incubated at a constant temperature under anaerobic conditions. The optimal temperature for methanogenesis is typically in the range of 35 to 45°C. Incubation temperature will be held constant at a value in this range that will be determined empirically through screening tests. The biogas evolved from the reactor will be trapped in an inverted water-filled vessel connected to the reactor by a capillary tube. The cumulative biogas volume will be determined at intervals by measuring water displacement and biogas composition (methane, carbon dioxide, nitrogen, and oxygen) and will be monitored non-destructively using a landfill gas analyzer connected inline to the gas trap. A Landtec Biogas 5000 gas analyzer will be used to periodically monitor CO_2, CH_4, and O_2 concentrations in the produced gas. The gas analyzer will be connected to the gas collection vessel in a closed loop so that the gas composition can be measured non-destructively over time. Monitoring intervals will be optimized and adjusted based on the rate of gas production.

The recorded volume and composition of biogas evolved over time will be used to calculate the methane and carbon dioxide production rates over the course of the test. Samples will be incubated for 30 to 60 days to provide sufficient data for calculation of biogas production rates. At the end of the test, the sediment sample will be recovered and analyzed for COD and LOC.

5.3.7 Extracted Subsurface NAPL Samples

Samples of extracted NAPL via shake test will be collected from subsurface sediment cores at locations and depth intervals that will be determined in the field. These samples will be analyzed to determine the physical properties of the extracted NAPL, including density, viscosity, wettability, and interfacial tension. In addition, the extracted NAPL will be tested for TPH chemical concentrations to serve as the basis for the percent mass TPH in sheen samples described in Section 5.5.

5.3.8 Additional Analyses

Additional analysis will be performed in the following two cases as described in Section 3.6 of the Work Plan:

- The upper four capping demonstration core intervals in the shallow region transect (0 to 2 feet, 2 to 5 feet, 5 to 7 feet, and 7 to 10 feet), and intermediate region transect (0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet) will be analyzed for the full suite of ROD Table 21 COCs (except chlorobenzene given this PTW-NRC chemical was identified based on FS-level evaluations that are not applicable to the Site). This will partially overlap with the ROD Table 17 analyte list to be evaluated for the capping demonstration objectives (i.e., PAHs).
- Up to 12 samples will be submitted for comprehensive hydrocarbon analysis:
  - Up to eight samples (pending field observations and NAPL availability) of the TPH extracts from NAPL samples obtained from shake tests (Section 5.3.7) will be submitted for comprehensive hydrocarbon analysis in addition to TPH analysis (analyses can be run on the same extract—no additional sample volume is needed).
  - Pending review of the subsurface sediment core boring logs and depending on the number and location of NAPL shake test samples submitted, 4 to 12 of the archived 1-foot interval subsurface sediment samples will be submitted for comprehensive hydrocarbon analysis.

5.4 Subsurface Porewater Samples

Subsurface porewater samples will be collected and analyzed using the following protocols:

- At 12 locations and intervals targeted for VOC characterization, samples will be analyzed for VOCs and dissolved organic carbon.
- At five locations and intervals with NAPL near the anticipated depth of dredge cuts based on preliminary assessment of slope stability concerns, samples will be analyzed for PAHs, VOCs, and dissolved organic carbon.

5.5 Active Sheen Blossom Testing

Ebullition sheen blossom samples will be submitted for TPH analysis.

5.6 Geotechnical Testing

Representative samples for laboratory testing of geotechnical index parameters, consolidation, and frictional strength will be chosen from depths where a stratigraphic change in the sediment sequence (e.g., change in lithology or depositional boundary contacts) is observed within each core. If no major stratigraphic changes are observed, at least one sample will be collected from an interval that best represents the core, with a maximum of five samples per core. Representative undisturbed samples for laboratory testing of consolidation and strength will be chosen from Shelby tubes collected at depths where fine-grained soils are present.

Samples will be tested for the following analytes:

- Disturbed and undisturbed samples:
  - Unit weight (bulk density) (ASTM D7263)
  - Grain size distribution (ASTM D6913 and D7928)
  - Moisture content (ASTM D2216)
  - Atterberg limits (ASTM D4318)
  - Specific gravity (ASTM D854)
- Undisturbed samples:
  - Consolidated undrained triaxial compression test (ASTM D4767)
  - Consolidated drained triaxial compression test (ASTM D7181)
  - UU triaxial compression test (ASTM D2850)
  - Direct shear test (ASTM D3080-11)
  - One-dimensional consolidation test (ASTM D2435)
  - Seepage-induced consolidation test (UC 1994)

Specific test assignments will be made after reviewing the subsurface stratigraphy interpretations so that test results are representative and comprehensive over the range of major stratigraphic units encountered. Table A-7 shows the anticipated frequency of the different tests.

6 Field Sampling Schedule

The Data Gaps Investigation sampling program is projected to begin as soon as possible after EPA approval of the Work Plan and associated documents, as well as the TEWP. The field sampling program is expected to be completed within 60 to 75 working days. The actual start and end dates for the sampling event will depend on EPA approval of the project plans and coordination with subcontractors. Other conditions that may affect the sampling schedule are weather, contractor availability, and equipment availability.

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Tables

Table A-1
Surface Sediment Sampling Locations

Sample Location	Purpose	Easting (X)	Northing (Y)
PDI-014	Interim Project Area Verification	7623560.18	706107.22
PDI-015	Interim Project Area Verification	7623644.48	706135.27
PDI-022	Interim Project Area Verification	7623834.35	705981.28
PDI-101	Interim Project Area Verification	7623359.76	706198.38
PDI-102	Interim Project Area Verification	7625261.85	705067.23
PDI-030	Additional Surface Sediment Data Density	7624449.12	705679.00
PDI-032	Additional Surface Sediment Data Density	7624519.86	705614.74
PDI-034	Additional Surface Sediment Data Density	7624574.36	705465.54
PDI-035	Additional Surface Sediment Data Density	7624612.41	705532.39
PDI-103	Recent Deposition Early Action Area	7623937.76	705620.25
PDI-104	Recent Deposition Early Action Area	7623958.77	705672.69
PDI-105	Recent Deposition Early Action Area	7624000.68	705581.74
PDI-106	Recent Deposition Early Action Area	7624019.85	705638.09

Note:
Coordinates are in North American Datum of 1983 (HARN91) Oregon State Plane North, International Feet.

Table A-2
Riverbank Angled Boring Sampling Location and Depth Intervals

Boring ID	Easting (X)[1]	Northing (Y)[1]	0 to 10 Feet	10 to 20 Feet	20 Feet to Bottom Depth	Bottom Depth[2] (bgs)	Approximate Boring Length[3] (feet)
PDI-134	7623170.91	705962.45	X	X	X	25.5	36
PDI-135	7623362.12	705848.62	X	X	X	26.2	37
PDI-136	7623577.90	705712.55	X	X		13.4	19
PDI-137	7623780.17	705605.00	X	X	X	17.7	25
PDI-138	7623937.19	705492.16	X	X	X	19.1	27
PDI-139	7624124.85	705365.50	X	X	X	25.5	36
PDI-140	7624270.77	705335.08	X	X		12.7	18
PDI-141	7624429.01	705238.11	X	X	X	17.7	25
PDI-142	7624617.81	705158.39	X	X	X	30.4	43
PDI-143	7624808.51	705042.43	X	X	X	31.1	44
PDI-144	7625008.28	704914.18	X	X	X	29.0	41
PDI-145	7625221.74	704792.77	X	X	X	24.7	35

Notes:
1. Coordinates are in North American Datum of 1983 (HARN91) Oregon State Plane North, International Feet.
2. Bottom depths were determined through the identification of the nearest offshore subsurface sampling location.
3. The approximate boring length was made using an entry angle of 45 degrees.
bgs: below ground surface

Table A-3
Subsurface Sediment Sampling Locations

Sediment Core Location	Easting (X)	Northing (Y)	Sampling Program										
					Cap Modelling							Additional Analysis	
			Interim Project Area Refinement	DOC[1]	Dredge and Cap or Capping Only Nearshore[2]	Dredge and Cap or Capping Only Offshore[3]	Waste Characterization[4]	Barge Dewatering (Dredge Elutriate)[4]	Porewater[5]	Biogas Generation Potential	NAPL Mobility	Nearshore[6]	Offshore[7]
PDI-013	7623533.10	706219.53	--	X	--	X	--	--	--	--	To be determined based on field observations of PTW-NAPL presence	--	--
PDI-014	7623560.18	706107.22	--	X	--	X	--	--	--	--		--	--
PDI-015	7623644.48	706135.27	--	X	--	X	X	X	--	--		--	--
PDI-016	7623622.57	706034.88	--	X	--	X	--	--	--	--		--	X
PDI-017	7623746.00	706121.00	--	X	--	X	--	--	--	--		--	--
PDI-018	7623782.65	706164.42	--	X	--	X	--	--	--	--		--	--
PDI-019	7623732.32	706037.75	--	X	--	X	--	--	--	--		--	--
PDI-020	7623727.46	705958.91	--	X	--	X	--	--	--	--		--	--
PDI-021	7623822.88	706067.97	--	X	--	X	--	--	--	--		--	--
PDI-022	7623834.35	705981.28	--	X	--	X	X	X	--	--		--	--
PDI-023	7623846.55	705910.83	--	X	--	X	--	--	--	--		--	X
PDI-024	7624058.78	705776.51	--	X	--	X	--	--	--	--		--	X
PDI-025	7624182.64	705719.51	--	X	--	X	--	--	--	--		--	--
PDI-026	7624194.63	705658.78	--	X	--	X	X	X	--	--		--	X
PDI-027	7624276.47	705622.55	--	X	--	X	--	--	--	--		--	--
PDI-028	7624336.00	705715.00	--	X	--	X	--	--	--	--		--	--
PDI-029	7624339.80	705645.22	--	X	--	X	--	--	--	--		--	--
PDI-030	7624449.12	705679.00	--	X	--	X	--	--	--	--		--	--
PDI-031	7624400.68	705574.66	--	X	--	X	X	X	--	--		--	X
PDI-032	7624519.86	705614.74	--	X	--	X	--	--	--	--		--	--
PDI-033	7624487.54	705512.82	--	X	--	X	--	--	--	--		--	--
PDI-034	7624574.36	705465.54	--	X	--	X	--	--	--	--		--	X
PDI-035	7624612.41	705532.39	--	X	--	X	X	X	--	--		--	--
PDI-036	7624634.30	705573.75	--	X	--	X	--	--	--	--		--	--
PDI-037	7624677.80	705388.29	--	X	--	X	X	X	X	--		--	--
PDI-038	7624692.32	705455.24	--	X	--	X	--	--	--	--		--	--
PDI-039	7624722.96	705524.69	--	X	--	X	--	--	--	--		--	--
PDI-040	7624778.23	705455.43	--	X	--	X	--	--	--	--		--	--
PDI-041	7624798.16	705356.24	--	X	--	X	--	--	--	--		--	X
PDI-042	7624882.60	705414.65	--	X	--	X	--	--	--	--		--	--
PDI-043	7624880.60	705324.69	--	X	--	X	--	--	--	--		--	--
PDI-044	7624942.72	705317.03	--	X	--	X	--	--	--	--		--	--
PDI-045	7624939.00	705255.00	--	X	--	X	--	--	X	--		--	X
PDI-046	7625017.10	705226.76	--	X	--	X	--	--	--	--		--	--
PDI-047	7625108.29	705149.31	--	X	--	X	--	--	--	--		--	X
PDI-048	7623499.23	705913.12	--	X	--	X	--	--	--	--		--	X
PDI-049	7623579.52	705961.29	--	X	--	X	--	--	--	X		--	X
PDI-050	7623535.35	705833.15	--	X	X	--	--	--	--	--		X	--

Table A-3
Subsurface Sediment Sampling Locations

Sediment Core Location	Easting (X)	Northing (Y)	Sampling Program										
					Cap Modelling							Additional Analysis	
			Interim Project Area Refinement	DOC[1]	Dredge and Cap or Capping Only Nearshore[2]	Dredge and Cap or Capping Only Offshore[3]	Waste Characterization[4]	Barge Dewatering (Dredge Elutriate)[4]	Porewater[5]	Biogas Generation Potential	NAPL Mobility	Nearshore[6]	Offshore[7]
PDI-051	7623605.33	705868.80	--	X	--	X	X	X	--	X	To be determined based on field observations of PTW-NAPL presence	--	X
PDI-052	7623674.61	705919.44	--	X	--	X	--	--	X	--		--	X
PDI-053	7623679.76	705748.94	--	X	X	--	--	--	--	--		X	--
PDI-054	7623730.57	705787.21	--	X	X	--	--	--	--	--		X	--
PDI-055	7623809.25	705849.87	--	X	--	X	--	--	X	--		--	X
PDI-056	7623784.26	705739.68	--	X	X	--	--	--	--	X		X	--
PDI-057	7623869.88	705739.20	--	X	--	X	--	--	--	--		--	X
PDI-058	7623864.68	705637.51	--	X	X	--	X	X	--	--		X	--
PDI-059	7623990.97	705693.89	--	X	--	X	--	--	X	X		--	X
PDI-060	7623961.15	705601.58	--	X	--	X	X	X	--	--		--	X
PDI-061	7624034.02	705558.07	--	X	--	X	--	--	--	--		--	X
PDI-062	7624122.98	705617.65	--	X	--	X	--	--	X	--		--	X
PDI-063	7624132.65	705477.49	--	X	X	--	--	--	--	X		X	--
PDI-064	7624209.09	705572.39	--	X	--	X	--	--	--	--		--	X
PDI-065	7624234.01	705431.95	--	X	X	--	--	--	--	--		X	--
PDI-066	7624290.22	705518.89	--	X	--	X	--	--	X	X		--	X
PDI-067	7624379.88	705473.57	--	X	--	X	--	--	X	--		--	X
PDI-068	7624364.42	705412.59	--	X	X	--	--	--	--	--		X	--
PDI-069	7624443.91	705404.10	--	X	--	X	--	--	--	--		--	X
PDI-070	7624424.91	705321.44	--	X	X	--	--	--	--	--		X	--
PDI-071	7624534.00	705407.00	--	X	--	X	--	--	--	X		--	X
PDI-072	7624505.92	705335.97	--	X	--	X	--	--	X	--		--	X
PDI-073	7624583.25	705333.41	--	X	--	X	X	X	--	--		--	X
PDI-074	7624724.03	705314.15	--	X	--	X	--	--	X	--		--	X
PDI-075	7624702.05	705227.69	--	X	--	X	--	--	--	--		--	X
PDI-076	7624791.00	705173.00	--	X	X	--	--	--	--	--		X	--
PDI-077	7624829.76	705245.29	--	X	--	X	--	--	X	--		--	X
PDI-078	7624864.35	705123.10	--	X	X	--	--	--	--	--		X	--
PDI-079	7624907.00	705161.00	--	X	--	X	--	--	--	X		--	X
PDI-080	7624947.58	705070.03	--	X	X	--	X	X	--	--		X	--
PDI-081	7624996.86	705142.77	--	X	--	X	--	--	X	--		--	X
PDI-082	7625063.58	705107.51	--	X	--	X	--	--	--	--		--	X
PDI-083	7625050.31	705043.44	--	X	--	X	--	--	--	--		--	X
PDI-084	7625124.24	705073.44	--	X	--	X	--	--	--	X		--	X
PDI-085	7623190.93	706070.85	--	--	X	--	--	--	--	--		X	--
PDI-086	7623235.47	706139.59	--	--	--	X	--	--	--	--		--	X
PDI-087	7623257.06	706032.73	--	--	X	--	--	--	--	--		X	--
PDI-088	7623306.60	706101.71	--	--	--	X	--	--	--	--		--	X
PDI-089	7623330.06	705976.90	--	--	X	--	--	--	--	--		X	--

Table A-3
Subsurface Sediment Sampling Locations

Sediment Core Location	Easting (X)	Northing (Y)	Sampling Program										
					Cap Modelling							Additional Analysis	
			Interim Project Area Refinement	DOC[1]	Dredge and Cap or Capping Only Nearshore[2]	Dredge and Cap or Capping Only Offshore[3]	Waste Characterization[4]	Barge Dewatering (Dredge Elutriate)[4]	Porewater[5]	Biogas Generation Potential	NAPL Mobility	Nearshore[6]	Offshore[7]
PDI-090	7623384.38	706053.36	--	--	--	X	--	--	--	X	To be determined based on field observations of PTW-NAPL presence	--	X
PDI-091	7623419.29	705941.73	--	--	--	X	--	--	--	--		--	X
PDI-092	7623467.87	706006.42	--	--	--	X	--	--	--	--		--	X
PDI-093	7625106.30	704958.83	--	--	X	--	--	--	--	--		X	--
PDI-094	7625181.95	704914.99	--	--	X	--	--	--	--	--		X	--
PDI-095	7625214.39	704970.87	--	--	--	X	--	--	--	--		--	X
PDI-096	7625251.64	704874.73	--	--	X	--	--	--	--	--		X	--
PDI-097	7625298.78	704926.71	--	--	--	X	X	X	--	--		--	X
PDI-098	7625323.48	704829.95	--	--	X	--	--	--	--	--		X	--
PDI-099	7625374.67	704880.13	--	--	--	X	--	--	--	--		--	X
PDI-100	7623824.13	706209.79	X	--	--	--	--	--	--	--		--	--
PDI-101	7623359.76	706198.38	X	--	--	--	--	--	--	--		--	--

Notes:
Coordinates are in North American Datum of 1983 (HARN91) Oregon State Plane North, International Feet.
1. Sampling intervals for DOC cores start at two successive intervals from the bottom depth of recovery toward the mudline. Remaining intervals will be archived in 1-foot intervals.
2. Sampling intervals for nearshore dredge and cap or capping-only cores are 0 to 2 feet, 2 to 5 feet, 5 to 7 feet, 7 to 10 feet, and 10 to 13 feet below mudline. Potentially deeper samples will be collected if PTW-NAPL is identified.
3. Sampling intervals for offshore dredge and cap or capping only cores outside the navigation channel are consecutive 2-foot intervals throughout core penetration. Sampling intervals for offshore dredge and cap cores inside the navigational channel are consecutive 2-foot intervals throughout the penetration depth starting at -47 feet COP elevation.
4. Waste characterization
5. Porewater samples will be collected from 4 to 6 feet below mudline.
6. Sampling intervals for nearshore additional analysis cores are 0 to 2 feet, 2 to 5 feet, and 5 to 7 feet below mudline.
7. Sampling intervals for offshore additional analysis cores are 0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline.
COP: City of Portland datum
DOC: depth of contamination
NAPL: nonaqueous phase liquid
PTW: principal threat waste

Table A-4
Subsurface Sediment Sampling Intervals

Sediment Core Location	Sampling Program										
	Interim Project Area Refinement	DOC[1]	Cap Modelling		Waste Characterization[4]	Barge Dewatering (Dredge Elutriate)[4]	Porewater[5]	Biogas Generation Potential	NAPL Mobility	Additional Analysis	
			Dredge and Cap or Capping Only Nearshore[2]	Dredge and Cap or Capping Only Offshore[3]						Nearshore	Offshore
PDI-013	--	Two consecutive 1-foot intervals from bottom depth of recovery, 1-foot samples (archive) above those samples to mudline	--	Consecutive 2-foot intervals throughout core penetration depth starting at -47 feet COP elevation	--	--	--	--	To be determined based on field observations of PTW-NAPL presence	--	--
PDI-014	--		--		--	--	--	--		--	--
PDI-015	--		--		Vertical composite from mudline to DOC	Vertical composite from mudline to DOC	--	--		--	--
PDI-016	--		--		--	--	--	--		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline
PDI-017	--		--		--	--	--	--		--	--
PDI-018	--		--		--	--	--	--		--	--
PDI-019	--		--		--	--	--	--		--	--
PDI-020	--		--		--	--	--	--		--	--
PDI-021	--		--		--	--	--	--		--	--
PDI-022	--		--		Vertical composite from mudline to DOC	Vertical composite from mudline to DOC	--	--		--	--
PDI-023	--		--		--	--	--	--		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline
PDI-024	--		--		--	--	--	--		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline
PDI-025	--		--		--	--	--	--		--	--
PDI-026	--		--		Vertical composite from mudline to DOC	Vertical composite from mudline to DOC	--	--		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline
PDI-027	--		--		--	--	--	--		--	--
PDI-028	--		--		--	--	--	--		--	--
PDI-029	--		--		--	--	--	--		--	--
PDI-030	--		--		--	--	--	--		--	--
PDI-031	--		--		Vertical composite from mudline to DOC	Vertical composite from mudline to DOC	--	--		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline
PDI-032	--		--		--	--	--	--		--	--
PDI-033	--		--		--	--	--	--		--	--
PDI-034	--		--		--	--	--	--		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline
PDI-035	--		--		Vertical composite from mudline to DOC	Vertical composite from mudline to DOC	--	--		--	--
PDI-036	--		--		--	--	--	--		--	--

Table A-4
Subsurface Sediment Sampling Intervals

Sediment Core Location	Sampling Program: Interim Project Area Refinement	DOC[1]	Cap Modelling: Dredge and Cap or Capping Only Nearshore[2]	Cap Modelling: Dredge and Cap or Capping Only Offshore[3]	Waste Characterization[4]	Barge Dewatering (Dredge Elutriate)[4]	Porewater[5]	Biogas Generation Potential	NAPL Mobility	Additional Analysis: Nearshore	Additional Analysis: Offshore
PDI-037	--	Two consecutive 1-foot intervals from bottom depth of recovery, 1-foot samples (archive) above those samples to mudline	--	Consecutive 2-foot intervals throughout core penetration depth starting at -47 feet COP elevation	Vertical composite from mudline to DOC	Vertical composite from mudline to DOC	4 to 6 feet below mudline	--	To be determined based on field observations of PTW-NAPL presence	--	--
PDI-038	--		--		--	--	--	--		--	--
PDI-039	--		--		--	--	--	--		--	--
PDI-040	--		--		--	--	--	--		--	--
PDI-041	--		--		--	--	--	--		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline
PDI-042	--		--		--	--	--	--		--	--
PDI-043	--		--		--	--	--	--		--	--
PDI-044	--		--		--	--	--	--		--	--
PDI-045	--		--		--	--	4 to 6 feet below mudline	--		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline
PDI-046	--		--		--	--	--	--		--	--
PDI-047	--		--		--	--	--	--		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline
PDI-048	--		--	Consecutive 2-foot intervals throughout core penetration depth	--	--	--	--		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline
PDI-049	--		--	Consecutive 2-foot intervals throughout core penetration depth	--	--	--	6 to 8 feet below mudline		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline
PDI-050	--		0- to 2-foot, 2- to 5-foot, 5- to 7-foot, 7- to 10-foot, and 10- to 13-foot intervals	--	--	--	--	--		0 to 2 feet, 2 to 5 feet, and 5 to 7 feet below mudline	--
PDI-051	--		--	Consecutive 2-foot intervals throughout core penetration depth	Vertical composite from mudline to DOC	Vertical composite from mudline to DOC	--	6 to 8 feet below mudline		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline
PDI-052	--		--	Consecutive 2-foot intervals throughout core penetration depth	--	--	4 to 6 feet below mudline	--		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline

Table A-4
Subsurface Sediment Sampling Intervals

Sediment Core Location	Sampling Program										
			Cap Modelling							Additional Analysis	
	Interim Project Area Refinement	DOC[1]	Dredge and Cap or Capping Only Nearshore[2]	Dredge and Cap or Capping Only Offshore[3]	Waste Characterization[4]	Barge Dewatering (Dredge Elutriate)[4]	Porewater[5]	Biogas Generation Potential	NAPL Mobility	Nearshore	Offshore
PDI-053	--	Two consecutive 1-foot intervals from bottom depth of recovery, 1-foot samples (archive) above those samples to mudline	0- to 2-foot, 2- to 5-foot, 5- to 7-foot, 7- to 10-foot, and 10- to 13-foot intervals	--	--	--	--	--	To be determined based on field observations of PTW-NAPL presence	0 to 2 feet, 2 to 5 feet, and 5 to 7 feet below mudline	--
PDI-054	--		0- to 2-foot, 2- to 5-foot, 5- to 7-foot, 7- to 10-foot, and 10- to 13-foot intervals	--	--	--	--	--		0 to 2 feet, 2 to 5 feet, and 5 to 7 feet below mudline	--
PDI-055	--		--	Consecutive 2-foot intervals throughout core penetration depth	--	--	4 to 6 feet below mudline	--		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline
PDI-056	--		0- to 2-foot, 2- to 5-foot, 5- to 7-foot, 7- to 10-foot, and 10- to 13-foot intervals	--	--	--	--	5 to 7 feet below mudline		0 to 2 feet, 2 to 5 feet, and 5 to 7 feet below mudline	--
PDI-057	--		--	Consecutive 2-foot intervals throughout core penetration depth	--	--	--	--		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline
PDI-058	--		0- to 2-foot, 2- to 5-foot, 5- to 7-foot, 7- to 10-foot, and 10- to 13-foot intervals	--	Vertical composite from mudline to DOC	Vertical composite from mudline to DOC	--	--		0 to 2 feet, 2 to 5 feet, and 5 to 7 feet below mudline	--
PDI-059	--		--	Consecutive 2-foot intervals throughout core penetration depth	--	--	4 to 6 feet below mudline	6 to 8 feet below mudline		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline
PDI-060	--		--	Consecutive 2-foot intervals throughout core penetration depth	Vertical composite from mudline to DOC	Vertical composite from mudline to DOC	--	--		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline
PDI-061	--		--	Consecutive 2-foot intervals throughout core penetration depth	--	--	--	--		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline

Table A-4
Subsurface Sediment Sampling Intervals

Sediment Core Location	Sampling Program										
			Cap Modelling							Additional Analysis	
	Interim Project Area Refinement	DOC[1]	Dredge and Cap or Capping Only Nearshore[2]	Dredge and Cap or Capping Only Offshore[3]	Waste Characterization[4]	Barge Dewatering (Dredge Elutriate)[4]	Porewater[5]	Biogas Generation Potential	NAPL Mobility	Nearshore	Offshore
PDI-062	--	Two consecutive 1-foot intervals from bottom depth of recovery, 1-foot samples (archive) above those samples to mudline	--	Consecutive 2-foot intervals throughout core penetration depth	--	--	4 to 6 feet below mudline	--	To be determined based on field observations of PTW-NAPL presence	--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline
PDI-063	--		0- to 2-foot, 2- to 5-foot, 5- to 7-foot, 7- to 10-foot, and 10- to 13-foot intervals	--	--	--	--	5 to 7 feet below mudline		0 to 2 feet, 2 to 5 feet, and 5 to 7 feet below mudline	--
PDI-064	--		--	Consecutive 2-foot intervals throughout core penetration depth	--	--	--	--		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline
PDI-065	--		0- to 2-foot, 2- to 5-foot, 5- to 7-foot, 7- to 10-foot, and 10- to 13-foot intervals	--	--	--	--	--		0 to 2 feet, 2 to 5 feet, and 5 to 7 feet below mudline	--
PDI-066	--		--	Consecutive 2-foot intervals throughout core penetration depth	--	--	4 to 6 feet below mudline	6 to 8 feet below mudline		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline
PDI-067	--		--	Consecutive 2-foot intervals throughout core penetration depth	--	--	4 to 6 feet below mudline	--		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline
PDI-068	--		0- to 2-foot, 2- to 5-foot, 5- to 7-foot, 7- to 10-foot, and 10- to 13-foot intervals	--	--	--	--	--		0 to 2 feet, 2 to 5 feet, and 5 to 7 feet below mudline	--
PDI-069	--		--	Consecutive 2-foot intervals throughout core penetration depth	--	--	--	--		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline
PDI-070	--		0- to 2-foot, 2- to 5-foot, 5- to 7-foot, 7- to 10-foot, and 10- to 13-foot intervals	--	--	--	--	--		0 to 2 feet, 2 to 5 feet, and 5 to 7 feet below mudline	--

Table A-4
Subsurface Sediment Sampling Intervals

Sediment Core Location	Sampling Program										
			Cap Modelling							Additional Analysis	
	Interim Project Area Refinement	DOC[1]	Dredge and Cap or Capping Only Nearshore[2]	Dredge and Cap or Capping Only Offshore[3]	Waste Characterization[4]	Barge Dewatering (Dredge Elutriate)[4]	Porewater[5]	Biogas Generation Potential	NAPL Mobility	Nearshore	Offshore
PDI-071	--	Two consecutive 1-foot intervals from bottom depth of recovery, 1-foot samples (archive) above those samples to mudline	--	Consecutive 2-foot intervals throughout core penetration depth	--	--	--	6 to 8 feet below mudline	To be determined based on field observations of PTW-NAPL presence	--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline
PDI-072	--		--	Consecutive 2-foot intervals throughout core penetration depth	--	--	4 to 6 feet below mudline	--		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline
PDI-073	--		--	Consecutive 2-foot intervals throughout core penetration depth	Vertical composite from mudline to DOC	Vertical composite from mudline to DOC	--	--		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline
PDI-074	--		--	Consecutive 2-foot intervals throughout core penetration depth	--	--	4 to 6 feet below mudline	--		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline
PDI-075	--		--	Consecutive 2-foot intervals throughout core penetration depth	--	--	--	--		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline
PDI-076	--		0- to 2-foot, 2- to 5-foot, 5- to 7-foot, 7- to 10-foot, and 10- to 13-foot intervals	--	--	--	--	--		0 to 2 feet, 2 to 5 feet, and 5 to 7 feet below mudline	--
PDI-077	--		--	Consecutive 2-foot intervals throughout core penetration depth	--	--	4 to 6 feet below mudline	--		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline
PDI-078	--		0- to 2-foot, 2- to 5-foot, 5- to 7-foot, 7- to 10-foot, and 10- to 13-foot intervals	--	--	--	--	--		0 to 2 feet, 2 to 5 feet, and 5 to 7 feet below mudline	--
PDI-079	--		--	Consecutive 2-foot intervals throughout core penetration depth	--	--	--	6 to 8 feet below mudline		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline

Table A-4
Subsurface Sediment Sampling Intervals

Sediment Core Location	Sampling Program										
	Interim Project Area Refinement	DOC[1]	Cap Modelling		Waste Characterization[4]	Barge Dewatering (Dredge Elutriate)[4]	Porewater[5]	Biogas Generation Potential	NAPL Mobility	Additional Analysis	
			Dredge and Cap or Capping Only Nearshore[2]	Dredge and Cap or Capping Only Offshore[3]						Nearshore	Offshore
PDI-080	--	Two consecutive 1-foot intervals from bottom depth of recovery, 1-foot samples (archive) above those samples to mudline	0- to 2-foot, 2- to 5-foot, 5- to 7-foot, 7- to 10-foot, and 10- to 13-foot intervals	--	Vertical composite from mudline to DOC	Vertical composite from mudline to DOC	--	--	To be determined based on field observations of PTW-NAPL presence	0 to 2 feet, 2 to 5 feet, and 5 to 7 feet below mudline	--
PDI-081	--		--	Consecutive 2-foot intervals throughout core penetration depth	--	--	4 to 6 feet below mudline	--		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline
PDI-082	--		--	Consecutive 2-foot intervals throughout core penetration depth	--	--	--	--		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline
PDI-083	--		--	Consecutive 2-foot intervals throughout core penetration depth	--	--	--	--		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline
PDI-084	--		--	Consecutive 2-foot intervals throughout core penetration depth	--	--	--	6 to 8 feet below mudline		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline
PDI-085	--	--	0- to 2-foot, 2- to 5-foot, 5- to 7-foot, 7- to 10-foot, and 10- to 13-foot intervals	--	--	--	--	--		0 to 2 feet, 2 to 5 feet, and 5 to 7 feet below mudline	--
PDI-086	--	--	--	Consecutive 2-foot intervals throughout core penetration depth	--	--	--	--		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline
PDI-087	--	--	0- to 2-foot, 2- to 5-foot, 5- to 7-foot, 7- to 10-foot, and 10- to 13-foot intervals	--	--	--	--	--		0 to 2 feet, 2 to 5 feet, and 5 to 7 feet below mudline	--
PDI-088	--	--	--	Consecutive 2-foot intervals throughout core penetration depth	--	--	--	--		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline

Table A-4
Subsurface Sediment Sampling Intervals

Sediment Core Location	Sampling Program											
			Cap Modelling							Additional Analysis	
	Interim Project Area Refinement	DOC[1]	Dredge and Cap or Capping Only Nearshore[2]	Dredge and Cap or Capping Only Offshore[3]	Waste Characterization[4]	Barge Dewatering (Dredge Elutriate)[4]	Porewater[5]	Biogas Generation Potential	NAPL Mobility	Nearshore	Offshore
PDI-089	--	--	0- to 2-foot, 2- to 5-foot, 5- to 7-foot, 7- to 10-foot, and 10- to 13-foot intervals	--	--	--	--	--		0 to 2 feet, 2 to 5 feet, and 5 to 7 feet below mudline	--
PDI-090	--	--	--	Consecutive 2-foot intervals throughout core penetration depth	--	--	--	6 to 8 feet below mudline		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline
PDI-091	--	--	--	Consecutive 2-foot intervals throughout core penetration depth	--	--	--	--		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline
PDI-092	--	--	--	Consecutive 2-foot intervals throughout core penetration depth	--	--	--	--		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline
PDI-093	--	--	0- to 2-foot, 2- to 5-foot, 5- to 7-foot, 7- to 10-foot, and 10- to 13-foot intervals	--	--	--	--	--	To be determined based on field observations of PTW-NAPL presence	0 to 2 feet, 2 to 5 feet, and 5 to 7 feet below mudline	--
PDI-094	--	--	0- to 2-foot, 2- to 5-foot, 5- to 7-foot, 7- to 10-foot, and 10- to 13-foot intervals	--	--	--	--	--		0 to 2 feet, 2 to 5 feet, and 5 to 7 feet below mudline	--
PDI-095	--	--	--	Consecutive 2-foot intervals throughout core penetration depth	--	--	--	--		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline
PDI-096	--	--	0- to 2-foot, 2- to 5-foot, 5- to 7-foot, 7- to 10-foot, and 10- to 13-foot intervals	--	--	--	--	--		0 to 2 feet, 2 to 5 feet, and 5 to 7 feet below mudline	--
PDI-097	--	--	--	Consecutive 2-foot intervals throughout core penetration depth	Vertical composite from mudline to DOC	Vertical composite from mudline to DOC	--	--		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline

Table A-4
Subsurface Sediment Sampling Intervals

Sediment Core Location	Sampling Program										
	Interim Project Area Refinement	DOC[1]	Cap Modelling		Waste Characterization[4]	Barge Dewatering (Dredge Elutriate)[4]	Porewater[5]	Biogas Generation Potential	NAPL Mobility	Additional Analysis	
			Dredge and Cap or Capping Only Nearshore[2]	Dredge and Cap or Capping Only Offshore[3]						Nearshore	Offshore
PDI-098	--	--	0- to 2-foot, 2- to 5-foot, 5- to 7-foot, 7- to 10-foot, and 10- to 13-foot intervals	--	--	--	--	--	To be determined based on field observations of PTW-NAPL presence	0 to 2 feet, 2 to 5 feet, and 5 to 7 feet below mudline	--
PDI-099	--	--	--	Consecutive 2-foot intervals throughout core penetration depth	--	--	--	--		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline
PDI-100	1 to 2 feet, 2 to 3 feet, and 3 to 4 feet below mudline	--	--	--	--	--	--	--		--	--
PDI-101	1 to 2 feet, 2 to 3 feet, and 3 to 4 feet below mudline	--	--	--	--	--	--	--		--	--

Table A-4
Subsurface Sediment Sampling Intervals

Notes:
1. Sampling intervals for DOC cores start at two successive intervals from the bottom depth of recovery toward the mudline. Remaining intervals will be archived in 1-foot intervals.
2. Sampling intervals for nearshore dredge and cap or capping-only cores are 0 to 2 feet, 2 to 5 feet, 5 to 7 feet, 7 to 10 feet, and 10 to 13 feet below mudline. Potentially deeper samples will be collected if PTW-NAPL is identified.
3. Sampling intervals for offshore dredge and cap or capping only cores outside the navigation channel are consecutive 2-foot intervals throughout core penetration. Sampling intervals for offshore dredge and cap cores inside the navigational channel are consecutive 2-foot intervals throughout the penetration depth starting at -47 feet COP elevation.
4. Waste characterization and barge dewatering samples will be collected from one vertically composited sample from existing mudline to the DOC, which will be estimated based on visual and olfactory indications of contamination.
5. Porewater samples will be collected from 4 to 6 feet below mudline unless PTW-NAPL is observed in that interval. If PTW-NAPL is observed, a new interval will be determined in the field.

COP: City of Portland datum
DOC: depth of contamination
NAPL: nonaqueous phase liquid
PTW: principal threat waste
TBD: to be determined

Table A-5
Geotechnical Core and In Situ Penetration Test Locations and Depths

Station Location	Target Coordinates[1] Easting (X)	Northing (Y)	Sampling Method	Target Penetration (feet)	Sample Intervals	Number of Cores per Station	Subsurface Sediment and Native Material Testing[2,3]	Archive
Geotechnical Coring								
PDI-107	7623201.14	706140.80	Sonic core barrel	Estimated at 5 to 10 feet of penetration below the bottom of proposed sheetpile depth (if consistent medium dense or very stiff conditions encountered), 65 feet below mudline, or to equipment/sampling refusal, whichever occurs first. Penetration depths will vary.	Varies based on sediment thickness and lithology; one to five intervals per core	1 to 2	Moisture content, Atterberg Limits, grain size, specific gravity, dry bulk density, one-dimensional consolidation, direct shear strength, and triaxial shear strength	Archive remaining intervals
PDI-108	7623421.47	706079.85						
PDI-109	7623516.04	705902.01						
PDI-110	7623716.76	706095.22						
PDI-111	7623811.41	705892.82						
PDI-112	7623903.08	705773.17						
PDI-113	7623974.01	705588.63						
PDI-114	7624223.06	705492.23						
PDI-115	7624283.66	705632.15						
PDI-116	7624422.86	705501.46						
PDI-117	7624540.51	705576.07						
PDI-118	7624673.71	705241.41						
PDI-119	7624768.47	705304.03						
PDI-120	7625067.33	705117.23						
PDI-121	7625034.17	705039.98						
PDI-122	7625194.92	705013.83						
PDI-123	7625357.86	704879.48						
In Situ Penetration Tests								
PDI-124	7623357.59	705978.41	CPT/FFP	Estimated at 5 to 10 feet of penetration below the bottom of proposed sheetpile depth (if consistent medium dense or very stiff conditions encountered), 65 feet below mudline, or to equipment/sampling refusal, whichever occurs first. Penetration depths will vary.	Data continuously collected during test as the probe is pushed into sediment and native material; no samples collected	1	In situ measurements of resistance, friction, and porewater pressure	N/A
PDI-125	7623677.16	705907.26						
PDI-126	7623892.42	705754.38						
PDI-127	7624130.84	705611.50						
PDI-128	7624414.12	705482.22						
PDI-129	7624467.21	705346.65						
PDI-130	7624584.84	705445.01						
PDI-131	7624847.95	705149.93						
PDI-132	7624969.33	705219.40						
PDI-133	7625216.42	704930.96						

Notes:
1. Coordinates are in North American Datum of 1983 (HARN91) Oregon State Plane North, International Feet.
2. All ASTM International test standards will be the most current adopted version, as of the time of sampling.
3. Bulk density includes both wet and dry results.
CPT: cone penetration test
FFP: full-flow penetration
N/A: not applicable

Table A-6
Sampling Intervals for All Programs

Sediment Core Location	Surface Sampling Program: Interim Project Area Verification	Surface Sampling Program: Additional Surface Sediment Data Density	Surface Sampling Program: Recent Deposition Early Action Area	Subsurface Sampling Program: DOC[1]	Subsurface Sampling Program: Cap Modelling: Dredge and Cap or Capping Only Nearshore[2]	Subsurface Sampling Program: Cap Modelling: Dredge and Cap or Capping Only Offshore[3]	Subsurface Sampling Program: Waste Characterization[4]	Subsurface Sampling Program: Barge Dewatering (Dredge Elutriate)[4]	Subsurface Sampling Program: Porewater[5]	Subsurface Sampling Program: Biogas Generation Potential	Subsurface Sampling Program: NAPL Mobility	Subsurface Sampling Program: Additional Analysis: Nearshore	Subsurface Sampling Program: Additional Analysis: Offshore	Angled Riverbank Borings	Geotechnical Program: Sonic Core	Geotechnical Program: CPT/FFP
PDI-013	--	--	--		--		--	--	--	--		--	--	--	--	--
PDI-014	3-point composite surface grab (0 to 30 cm)	--	--		--		--	--	--	--		--	--	--	--	--
PDI-015	3-point composite surface grab (0 to 30 cm)	--	--		--		Vertical composite from mudline to DOC	Vertical composite from mudline to DOC	--	--		--	--	--	--	--
PDI-016	--	--	--		--		--	--	--	--		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline	--	--	--
PDI-017	--	--	--		--		--	--	--	--		--	--	--	--	--
PDI-018	--	--	--		--		--	--	--	--		--	--	--	--	--
PDI-019	--	--	--		--		--	--	--	--		--	--	--	--	--
PDI-020	--	--	--		--		--	--	--	--		--	--	--	--	--
PDI-021	--	--	--		--		--	--	--	--		--	--	--	--	--
PDI-022	3-point composite surface grab (0 to 30 cm)	--	--		--		Vertical composite from mudline to DOC	Vertical composite from mudline to DOC	--	--		--	--	--	--	--
PDI-023	--	--	--		--		--	--	--	--		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline	--	--	--
PDI-024	--	--	--		--		--	--	--	--		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline	--	--	--
PDI-025	--	--	--	Two consecutive 1-foot intervals from bottom depth of recovery, 1-foot samples (archive) above those samples to mudline	--	Consecutive 2-foot intervals throughout core penetration depth starting at -47 feet COP elevation	--	--	--	--	To be determined based on field observations of PTW-NAPL presence	--	--	--	--	--
PDI-026	--	--	--		--		Vertical composite from mudline to DOC	Vertical composite from mudline to DOC	--	--		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline	--	--	--
PDI-027	--	--	--		--		--	--	--	--		--	--	--	--	--
PDI-028	--	--	--		--		--	--	--	--		--	--	--	--	--
PDI-029	--	--	--		--		--	--	--	--		--	--	--	--	--
PDI-030	--	Core interval (0 to 1 foot below mudline)	--		--		--	--	--	--		--	--	--	--	--
PDI-031	--	--	--		--		Vertical composite from mudline to DOC	Vertical composite from mudline to DOC	--	--		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline	--	--	--
PDI-032	--	Core interval (0 to 1 foot below mudline)	--		--		--	--	--	--		--	--	--	--	--
PDI-033	--	--	--		--		--	--	--	--		--	--	--	--	--
PDI-034	--	Core interval (0 to 1 foot below mudline)	--		--		--	--	--	--		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline	--	--	--
PDI-035	--	Core interval (0 to 1 foot below mudline)	--		--		Vertical composite from mudline to DOC	Vertical composite from mudline to DOC	--	--		--	--	--	--	--
PDI-036	--	--	--		--		--	--	--	--		--	--	--	--	--

Table A-6
Sampling Intervals for All Programs

	Surface Sampling Program			Subsurface Sampling Program											Geotechnical Program	
					Cap Modelling							Additional Analysis				
Sediment Core Location	Interim Project Area Verification	Additional Surface Sediment Data Density	Recent Deposition Early Action Area	DOC[1]	Dredge and Cap or Capping Only Nearshore[2]	Dredge and Cap or Capping Only Offshore[3]	Waste Characterization[4]	Barge Dewatering (Dredge Elutriate)[4]	Porewater[5]	Biogas Generation Potential	NAPL Mobility	Nearshore	Offshore	Angled Riverbank Borings	Sonic Core	CPT/FFP
PDI-037	--	--	--	Two consecutive 1-foot intervals from bottom depth of recovery, 1-foot samples (archive) above those samples to mudline	--	Consecutive 2-foot intervals throughout core penetration depth starting at -47 feet COP elevation	Vertical composite from mudline to DOC	Vertical composite from mudline to DOC	4 to 6 feet below mudline	--	To be determined based on field observations of PTW-NAPL presence	--	--	--	--	--
PDI-038	--	--	--		--		--	--	--	--		--	--	--	--	--
PDI-039	--	--	--		--		--	--	--	--		--	--	--	--	--
PDI-040	--	--	--		--		--	--	--	--		--	--	--	--	--
PDI-041	--	--	--		--		--	--	--	--		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline	--	--	--
PDI-042	--	--	--		--		--	--	--	--		--	--	--	--	--
PDI-043	--	--	--		--		--	--	--	--		--	--	--	--	--
PDI-044	--	--	--		--		--	--	--	--		--	--	--	--	--
PDI-045	--	--	--		--		--	--	4 to 6 feet below mudline	--		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline	--	--	--
PDI-046	--	--	--		--		--	--	--	--		--	--	--	--	--
PDI-047	--	--	--		--		--	--	--	--		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline	--	--	--
PDI-048	--	--	--		--	Consecutive 2-foot intervals throughout core penetration depth	--	--	--	--		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline	--	--	--
PDI-049	--	--	--		--	Consecutive 2-foot intervals throughout core penetration depth	--	--	--	6 to 8 feet below mudline		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline	--	--	--
PDI-050	--	--	--		0- to 2-foot, 2- to 5-foot, 5- to 7-foot, 7- to 10-foot, and 10- to 13-foot intervals	--	--	--	--	--		0 to 2 feet, 2 to 5 feet, and 5 to 7 feet below mudline	--	--	--	--
PDI-051	--	--	--		--	Consecutive 2-foot intervals throughout core penetration depth	Vertical composite from mudline to DOC	Vertical composite from mudline to DOC	--	6 to 8 feet below mudline		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline	--	--	--
PDI-052	--	--	--		--	Consecutive 2-foot intervals throughout core penetration depth	--	--	4 to 6 feet below mudline	--		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline	--	--	--

Table A-6
Sampling Intervals for All Programs

	Surface Sampling Program			Subsurface Sampling Program											Geotechnical Program	
					Cap Modelling							Additional Analysis				
Sediment Core Location	Interim Project Area Verification	Additional Surface Sediment Data Density	Recent Deposition Early Action Area	DOC[1]	Dredge and Cap or Capping Only Nearshore[2]	Dredge and Cap or Capping Only Offshore[3]	Waste Characterization[4]	Barge Dewatering (Dredge Elutriate)[4]	Porewater[5]	Biogas Generation Potential	NAPL Mobility	Nearshore	Offshore	Angled Riverbank Borings	Sonic Core	CPT/FFP
PDI-053	--	--	--	Two consecutive 1-foot intervals from bottom depth of recovery, 1-foot samples (archive) above those samples to mudline	0- to 2-foot, 2- to 5-foot, 5- to 7-foot, 7- to 10-foot, and 10- to 13-foot intervals	--	--	--	--	--	To be determined based on field observations of PTW-NAPL presence	0 to 2 feet, 2 to 5 feet, and 5 to 7 feet below mudline	--	--	--	--
PDI-054	--	--	--		0- to 2-foot, 2- to 5-foot, 5- to 7-foot, 7- to 10-foot, and 10- to 13-foot intervals	--	--	--	--	--		0 to 2 feet, 2 to 5 feet, and 5 to 7 feet below mudline	--	--	--	--
PDI-055	--	--	--		--	Consecutive 2-foot intervals throughout core penetration depth	--	--	4 to 6 feet below mudline	--		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline	--	--	--
PDI-056	--	--	--		0- to 2-foot, 2- to 5-foot, 5- to 7-foot, 7- to 10-foot, and 10- to 13-foot intervals	--	--	--	--	5 to 7 feet below mudline		0 to 2 feet, 2 to 5 feet, and 5 to 7 feet below mudline	--	--	--	--
PDI-057	--	--	--		--	Consecutive 2-foot intervals throughout core penetration depth	--	--	--	--		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline	--	--	--
PDI-058	--	--	--		0- to 2-foot, 2- to 5-foot, 5- to 7-foot, 7- to 10-foot, and 10- to 13-foot intervals	--	Vertical composite from mudline to DOC	Vertical composite from mudline to DOC	--	--		0 to 2 feet, 2 to 5 feet, and 5 to 7 feet below mudline	--	--	--	--
PDI-059	--	--	--		--	Consecutive 2-foot intervals throughout core penetration depth	--	--	4 to 6 feet below mudline	6 to 8 feet below mudline		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline	--	--	--
PDI-060	--	--	--		--	Consecutive 2-foot intervals throughout core penetration depth	Vertical composite from mudline to DOC	Vertical composite from mudline to DOC	--	--		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline	--	--	--
PDI-061	--	--	--		--	Consecutive 2-foot intervals throughout core penetration depth	--	--	--	--		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline	--	--	--

Table A-6
Sampling Intervals for All Programs

Sediment Core Location	Surface Sampling Program			Subsurface Sampling Program										Angled Riverbank Borings	Geotechnical Program	
	Interim Project Area Verification	Additional Surface Sediment Data Density	Recent Deposition Early Action Area	DOC[1]	Cap Modelling: Dredge and Cap or Capping Only Nearshore[2]	Cap Modelling: Dredge and Cap or Capping Only Offshore[3]	Waste Characterization[4]	Barge Dewatering (Dredge Elutriate)[4]	Porewater[5]	Biogas Generation Potential	NAPL Mobility	Additional Analysis: Nearshore	Additional Analysis: Offshore		Sonic Core	CPT/FFP
PDI-062	--	--	--	Two consecutive 1-foot intervals from bottom depth of recovery, 1-foot samples (archive) above those samples to mudline	--	Consecutive 2-foot intervals throughout core penetration depth	--	--	4 to 6 feet below mudline	--	To be determined based on field observations of PTW-NAPL presence	--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline	--	--	--
PDI-063	--	--	--		0- to 2-foot, 2- to 5-foot, 5- to 7-foot, 7- to 10-foot, and 10- to 13-foot intervals	--	--	--	--	5 to 7 feet below mudline		0 to 2 feet, 2 to 5 feet, and 5 to 7 feet below mudline	--	--	--	--
PDI-064	--	--	--		--	Consecutive 2-foot intervals throughout core penetration depth	--	--	--	--		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline	--	--	--
PDI-065	--	--	--		0- to 2-foot, 2- to 5-foot, 5- to 7-foot, 7- to 10-foot, and 10- to 13-foot intervals	--	--	--	--	--		0 to 2 feet, 2 to 5 feet, and 5 to 7 feet below mudline	--	--	--	--
PDI-066	--	--	--		--	Consecutive 2-foot intervals throughout core penetration depth	--	--	4 to 6 feet below mudline	6 to 8 feet below mudline		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline	--	--	--
PDI-067	--	--	--		--	Consecutive 2-foot intervals throughout core penetration depth	--	--	4 to 6 feet below mudline	--		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline	--	--	--
PDI-068	--	--	--		0- to 2-foot, 2- to 5-foot, 5- to 7-foot, 7- to 10-foot, and 10- to 13-foot intervals	--	--	--	--	--		0 to 2 feet, 2 to 5 feet, and 5 to 7 feet below mudline	--	--	--	--
PDI-069	--	--	--		--	Consecutive 2-foot intervals throughout core penetration depth	--	--	--	--		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline	--	--	--
PDI-070	--	--	--		0- to 2-foot, 2- to 5-foot, 5- to 7-foot, 7- to 10-foot, and 10- to 13-foot intervals	--	--	--	--	--		0 to 2 feet, 2 to 5 feet, and 5 to 7 feet below mudline	--	--	--	--

Table A-6
Sampling Intervals for All Programs

	Surface Sampling Program			Subsurface Sampling Program											Geotechnical Program	
					Cap Modelling							Additional Analysis				
Sediment Core Location	Interim Project Area Verification	Additional Surface Sediment Data Density	Recent Deposition Early Action Area	DOC[1]	Dredge and Cap or Capping Only Nearshore[2]	Dredge and Cap or Capping Only Offshore[3]	Waste Characterization[4]	Barge Dewatering (Dredge Elutriate)[4]	Porewater[5]	Biogas Generation Potential	NAPL Mobility	Nearshore	Offshore	Angled Riverbank Borings	Sonic Core	CPT/FFP
PDI-071	--	--	--	Two consecutive 1-foot intervals from bottom depth of recovery, 1-foot samples (archive) above those samples to mudline	--	Consecutive 2-foot intervals throughout core penetration depth	--	--	--	6 to 8 feet below mudline	To be determined based on field observations of PTW-NAPL presence	--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline	--	--	--
PDI-072	--	--	--		--	Consecutive 2-foot intervals throughout core penetration depth	--	--	4 to 6 feet below mudline	--		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline	--	--	--
PDI-073	--	--	--		--	Consecutive 2-foot intervals throughout core penetration depth	Vertical composite from mudline to DOC	Vertical composite from mudline to DOC	--	--		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline	--	--	--
PDI-074	--	--	--		--	Consecutive 2-foot intervals throughout core penetration depth	--	--	4 to 6 feet below mudline	--		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline	--	--	--
PDI-075	--	--	--		--	Consecutive 2-foot intervals throughout core penetration depth	--	--	--	--		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline	--	--	--
PDI-076	--	--	--		0- to 2-foot, 2- to 5-foot, 5- to 7-foot, 7- to 10-foot, and 10- to 13-foot intervals	--	--	--	--	--		0 to 2 feet, 2 to 5 feet, and 5 to 7 feet below mudline	--	--	--	--
PDI-077	--	--	--		--	Consecutive 2-foot intervals throughout core penetration depth	--	--	4 to 6 feet below mudline	--		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline	--	--	--
PDI-078	--	--	--		0- to 2-foot, 2- to 5-foot, 5- to 7-foot, 7- to 10-foot, and 10- to 13-foot intervals	--	--	--	--	--		0 to 2 feet, 2 to 5 feet, and 5 to 7 feet below mudline	--	--	--	--
PDI-079	--	--	--		--	Consecutive 2-foot intervals throughout core penetration depth	--	--	--	6 to 8 feet below mudline		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline	--	--	--

Table A-6
Sampling Intervals for All Programs

Sediment Core Location	Surface Sampling Program			Subsurface Sampling Program											Geotechnical Program	
	Interim Project Area Verification	Additional Surface Sediment Data Density	Recent Deposition Early Action Area	DOC[1]	Cap Modelling: Dredge and Cap or Capping Only Nearshore[2]	Cap Modelling: Dredge and Cap or Capping Only Offshore[3]	Waste Characterization[4]	Barge Dewatering (Dredge Elutriate)[4]	Porewater[5]	Biogas Generation Potential	NAPL Mobility	Additional Analysis: Nearshore	Additional Analysis: Offshore	Angled Riverbank Borings	Sonic Core	CPT/FFP
PDI-080	--	--	--	Two consecutive 1-foot intervals from bottom depth of recovery, 1-foot samples (archive) above those samples to mudline	0- to 2-foot, 2- to 5-foot, 5- to 7-foot, 7- to 10-foot, and 10- to 13-foot intervals	--	Vertical composite from mudline to DOC	Vertical composite from mudline to DOC	--	--	To be determined based on field observations of PTW-NAPL presence	0 to 2 feet, 2 to 5 feet, and 5 to 7 feet below mudline	--	--	--	--
PDI-081	--	--	--		--	Consecutive 2-foot intervals throughout core penetration depth	--	--	4 to 6 feet below mudline	--		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline	--	--	--
PDI-082	--	--	--		--	Consecutive 2-foot intervals throughout core penetration depth	--	--	--	--		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline	--	--	--
PDI-083	--	--	--		--	Consecutive 2-foot intervals throughout core penetration depth	--	--	--	--		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline	--	--	--
PDI-084	--	--	--		--	Consecutive 2-foot intervals throughout core penetration depth	--	--	--	6 to 8 feet below mudline		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline	--	--	--
PDI-085	--	--	--	--	0- to 2-foot, 2- to 5-foot, 5- to 7-foot, 7- to 10-foot, and 10- to 13-foot intervals	--	--	--	--	--		0 to 2 feet, 2 to 5 feet, and 5 to 7 feet below mudline	--	--	--	--
PDI-086	--	--	--	--	--	Consecutive 2-foot intervals throughout core penetration depth	--	--	--	--		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline	--	--	--
PDI-087	--	--	--	--	0- to 2-foot, 2- to 5-foot, 5- to 7-foot, 7- to 10-foot, and 10- to 13-foot intervals	--	--	--	--	--		0 to 2 feet, 2 to 5 feet, and 5 to 7 feet below mudline	--	--	--	--
PDI-088	--	--	--	--	--	Consecutive 2-foot intervals throughout core penetration depth	--	--	--	--		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline	--	--	--

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Sampling Intervals for All Programs

	Surface Sampling Program			Subsurface Sampling Program											Geotechnical Program	
					Cap Modelling							Additional Analysis				
Sediment Core Location	Interim Project Area Verification	Additional Surface Sediment Data Density	Recent Deposition Early Action Area	DOC[1]	Dredge and Cap or Capping Only Nearshore[2]	Dredge and Cap or Capping Only Offshore[3]	Waste Characterization[4]	Barge Dewatering (Dredge Elutriate)[4]	Porewater[5]	Biogas Generation Potential	NAPL Mobility	Nearshore	Offshore	Angled Riverbank Borings	Sonic Core	CPT/FFP
PDI-089	--	--	--	--	0- to 2-foot, 2- to 5-foot, 5- to 7-foot, 7- to 10-foot, and 10- to 13-foot intervals	--	--	--	--	--		0 to 2 feet, 2 to 5 feet, and 5 to 7 feet below mudline	--	--	--	--
PDI-090	--	--	--	--	--	Consecutive 2-foot intervals throughout core penetration depth	--	--	--	6 to 8 feet below mudline		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline	--	--	--
PDI-091	--	--	--	--	--	Consecutive 2-foot intervals throughout core penetration depth	--	--	--	--		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline	--	--	--
PDI-092	--	--	--	--	--	Consecutive 2-foot intervals throughout core penetration depth	--	--	--	--		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline	--	--	--
PDI-093	--	--	--	--	0- to 2-foot, 2- to 5-foot, 5- to 7-foot, 7- to 10-foot, and 10- to 13-foot intervals	--	--	--	--	--	To be determined based on field observations of PTW-NAPL presence	0 to 2 feet, 2 to 5 feet, and 5 to 7 feet below mudline	--	--	--	--
PDI-094	--	--	--	--	0- to 2-foot, 2- to 5-foot, 5- to 7-foot, 7- to 10-foot, and 10- to 13-foot intervals	--	--	--	--	--		0 to 2 feet, 2 to 5 feet, and 5 to 7 feet below mudline	--	--	--	--
PDI-095	--	--	--	--	--	Consecutive 2-foot intervals throughout core penetration depth	--	--	--	--		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline	--	--	--
PDI-096	--	--	--	--	0- to 2-foot, 2- to 5-foot, 5- to 7-foot, 7- to 10-foot, and 10- to 13-foot intervals	--	--	--	--	--		0 to 2 feet, 2 to 5 feet, and 5 to 7 feet below mudline	--	--	--	--
PDI-097	--	--	--	--	--	Consecutive 2-foot intervals throughout core penetration depth	Vertical composite from mudline to DOC	Vertical composite from mudline to DOC	--	--		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline	--	--	--

Table A-6
Sampling Intervals for All Programs

	Surface Sampling Program			Subsurface Sampling Program											Geotechnical Program	
					Cap Modelling							Additional Analysis				
Sediment Core Location	Interim Project Area Verification	Additional Surface Sediment Data Density	Recent Deposition Early Action Area	DOC[1]	Dredge and Cap or Capping Only Nearshore[2]	Dredge and Cap or Capping Only Offshore[3]	Waste Characterization[4]	Barge Dewatering (Dredge Elutriate)[4]	Porewater[5]	Biogas Generation Potential	NAPL Mobility	Nearshore	Offshore	Angled Riverbank Borings	Sonic Core	CPT/FFP
PDI-098	--	--	--	--	0- to 2-foot, 2- to 5-foot, 5- to 7-foot, 7- to 10-foot, and 10- to 13-foot intervals	--	--	--	--	--	To be determined based on field observations of PTW-NAPL presence	0 to 2 feet, 2 to 5 feet, and 5 to 7 feet below mudline	--	--	--	--
PDI-099	--	--	--	--	--	Consecutive 2-foot intervals throughout core penetration depth	--	--	--	--		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline	--	--	--
PDI-100	--	--	--	--	--	--	--	--	--	--		--	1 to 2 feet, 2 to 3 feet, and 3 to 4 feet below mudline	--	--	--
PDI-101	3-point composite surface grab (0 to 30 cm)	--	--	--	--	--	--	--	--	--		--	1 to 2 feet, 2 to 3 feet, and 3 to 4 feet below mudline	--	--	--
PDI-102	3-point composite surface grab (0 to 30 cm)	--	--	--	--	--	--	--	--	--		--	--	--	--	--
PDI-103	--	--	Discrete surface grab (0 to 30 cm)	--	--	--	--	--	--	--		--	--	--	--	--
PDI-104	--	--	Discrete surface grab (0 to 30 cm)	--	--	--	--	--	--	--		--	--	--	--	--
PDI-105	--	--	Discrete surface grab (0 to 30 cm)	--	--	--	--	--	--	--		--	--	--	--	--
PDI-106	--	--	Discrete surface grab (0 to 30 cm)	--	--	--	--	--	--	--		--	--	--	--	--
PDI-107	--	--	--	--	--	--	--	--	--	--		--	--	--	Varies based on sediment thickness and lithology; one to five intervals per core	--
PDI-108	--	--	--	--	--	--	--	--	--	--		--	--	--	Varies based on sediment thickness and lithology; one to five intervals per core	--
PDI-109	--	--	--	--	--	--	--	--	--	--		--	--	--	Varies based on sediment thickness and lithology; one to five intervals per core	--
PDI-110	--	--	--	--	--	--	--	--	--	--		--	--	--	Varies based on sediment thickness and lithology; one to five intervals per core	--

Table A-6
Sampling Intervals for All Programs

	Surface Sampling Program			Subsurface Sampling Program											Geotechnical Program	
					Cap Modelling							Additional Analysis				
Sediment Core Location	Interim Project Area Verification	Additional Surface Sediment Data Density	Recent Deposition Early Action Area	DOC[1]	Dredge and Cap or Capping Only Nearshore[2]	Dredge and Cap or Capping Only Offshore[3]	Waste Characterization[4]	Barge Dewatering (Dredge Elutriate)[4]	Porewater[5]	Biogas Generation Potential	NAPL Mobility	Nearshore	Offshore	Angled Riverbank Borings	Sonic Core	CPT/FFP
PDI-111	--	--	--	--	--	--	--	--	--	--		--	--	--	Varies based on sediment thickness and lithology; one to five intervals per core	--
PDI-112	--	--	--	--	--	--	--	--	--	--		--	--	--	Varies based on sediment thickness and lithology; one to five intervals per core	--
PDI-113	--	--	--	--	--	--	--	--	--	--		--	--	--	Varies based on sediment thickness and lithology; one to five intervals per core	--
PDI-114	--	--	--	--	--	--	--	--	--	--		--	--	--	Varies based on sediment thickness and lithology; one to five intervals per core	--
PDI-115	--	--	--	--	--	--	--	--	--	--		--	--	--	Varies based on sediment thickness and lithology; one to five intervals per core	--
PDI-116	--	--	--	--	--	--	--	--	--	--		--	--	--	Varies based on sediment thickness and lithology; one to five intervals per core	--
PDI-117	--	--	--	--	--	--	--	--	--	--		--	--	--	Varies based on sediment thickness and lithology; one to five intervals per core	--
PDI-118	--	--	--	--	--	--	--	--	--	--		--	--	--	Varies based on sediment thickness and lithology; one to five intervals per core	--
PDI-119	--	--	--	--	--	--	--	--	--	--		--	--	--	Varies based on sediment thickness and lithology; one to five intervals per core	--
PDI-120	--	--	--	--	--	--	--	--	--	--		--	--	--	Varies based on sediment thickness and lithology; one to five intervals per core	--
PDI-121	--	--	--	--	--	--	--	--	--	--		--	--	--	Varies based on sediment thickness and lithology; one to five intervals per core	--
PDI-122	--	--	--	--	--	--	--	--	--	--		--	--	--	Varies based on sediment thickness and lithology; one to five intervals per core	--
PDI-123	--	--	--	--	--	--	--	--	--	--		--	--	--	Varies based on sediment thickness and lithology; one to five intervals per core	--

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Sampling Intervals for All Programs

	Surface Sampling Program			Subsurface Sampling Program											Geotechnical Program	
					Cap Modelling							Additional Analysis				
Sediment Core Location	Interim Project Area Verification	Additional Surface Sediment Data Density	Recent Deposition Early Action Area	DOC[1]	Dredge and Cap or Capping Only Nearshore[2]	Dredge and Cap or Capping Only Offshore[3]	Waste Characterization[4]	Barge Dewatering (Dredge Elutriate)[4]	Porewater[5]	Biogas Generation Potential	NAPL Mobility	Nearshore	Offshore	Angled Riverbank Borings	Sonic Core	CPT/FFP
PDI-124	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	Data continuously collected during test as the probe is pushed into sediment and native material; no samples collected
PDI-125	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	Data continuously collected during test as the probe is pushed into sediment and native material; no samples collected
PDI-126	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	Data continuously collected during test as the probe is pushed into sediment and native material; no samples collected
PDI-127	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	Data continuously collected during test as the probe is pushed into sediment and native material; no samples collected
PDI-128	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	Data continuously collected during test as the probe is pushed into sediment and native material; no samples collected
PDI-129	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	Data continuously collected during test as the probe is pushed into sediment and native material; no samples collected
PDI-130	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	Data continuously collected during test as the probe is pushed into sediment and native material; no samples collected
PDI-131	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	Data continuously collected during test as the probe is pushed into sediment and native material; no samples collected
PDI-132	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	Data continuously collected during test as the probe is pushed into sediment and native material; no samples collected
PDI-133	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	Data continuously collected during test as the probe is pushed into sediment and native material; no samples collected

Table A-6
Sampling Intervals for All Programs

	Surface Sampling Program			Subsurface Sampling Program											Geotechnical Program	
					Cap Modelling							Additional Analysis				
Sediment Core Location	Interim Project Area Verification	Additional Surface Sediment Data Density	Recent Deposition Early Action Area	DOC[1]	Dredge and Cap or Capping Only Nearshore[2]	Dredge and Cap or Capping Only Offshore[3]	Waste Characterization[4]	Barge Dewatering (Dredge Elutriate)[4]	Porewater[5]	Biogas Generation Potential	NAPL Mobility	Nearshore	Offshore	Angled Riverbank Borings	Sonic Core	CPT/FFP
PDI-134	--	--	--	--	--	--	Vertical composite from ground surface to DOC	--	--	--	To be determined based on field observations of PTW-NAPL presence	--	--	0 to 10 feet below ground surface, 10 to 20 feet below ground surface, and 20 feet below ground surface to bottom of boring	--	--
PDI-135	--	--	--	--	--	--	--	--	--	--		--	--	0 to 10 feet below ground surface, 10 to 20 feet below ground surface, and 20 feet below ground surface to bottom of boring	--	--
PDI-136	--	--	--	--	--	--	Vertical composite from ground surface to DOC	--	--	--		--	--	0 to 10 feet below ground surface, 10 to bottom of boring	--	--
PDI-137	--	--	--	--	--	--	--	--	--	--		--	--	0 to 10 feet below ground surface, 10 to 20 feet below ground surface, and 20 feet below ground surface to bottom of boring	--	--
PDI-138	--	--	--	--	--	--	Vertical composite from ground surface to DOC	--	--	--		--	--	0 to 10 feet below ground surface, 10 to 20 feet below ground surface, and 20 feet below ground surface to bottom of boring	--	--
PDI-139	--	--	--	--	--	--	--	--	--	--		--	--	0 to 10 feet below ground surface, 10 to 20 feet below ground surface, and 20 feet below ground surface to bottom of boring	--	--
PDI-140	--	--	--	--	--	--	Vertical composite from ground surface to DOC	--	--	--		--	--	0 to 10 feet below ground surface, 10 to bottom of boring	--	--
PDI-141	--	--	--	--	--	--	--	--	--	--		--	--	0 to 10 feet below ground surface, 10 to 20 feet below ground surface, and 20 feet below ground surface to bottom of boring	--	--
PDI-142	--	--	--	--	--	--	Vertical composite from ground surface to DOC	--	--	--		--	--	0 to 10 feet below ground surface, 10 to 20 feet below ground surface, and 20 feet below ground surface to bottom of boring	--	--
PDI-143	--	--	--	--	--	--	--	--	--	--		--	--	0 to 10 feet below ground surface, 10 to 20 feet below ground surface, and 20 feet below ground surface to bottom of boring	--	--
PDI-144	--	--	--	--	--	--	Vertical composite from ground surface to DOC	--	--	--		--	--	0 to 10 feet below ground surface, 10 to 20 feet below ground surface, and 20 feet below ground surface to bottom of boring	--	--
PDI-145	--	--	--	--	--	--	--	--	--	--		--	--	0 to 10 feet below ground surface, 10 to 20 feet below ground surface, and 20 feet below ground surface to bottom of boring	--	--

Table A-6
Subsurface Sediment Sampling Intervals

Notes:
1. Sampling intervals for DOC cores start at two successive intervals from the bottom depth of recovery toward the mudline. Remaining intervals will be archived in 1-foot intervals.
2. Sampling intervals for nearshore dredge and cap or capping-only cores are 0 to 2 feet, 2 to 5 feet, 5 to 7 feet, 7 to 10 feet, and 10 to 13 feet below mudline. Potentially deeper samples will be collected if PTW-NAPL is identified.
3. Sampling intervals for offshore dredge and cap or capping only cores outside the navigation channel are consecutive 2-foot intervals throughout core penetration. Sampling intervals for offshore dredge and cap cores inside the navigational channel are consecutive 2-foot intervals throughout the penetration depth starting at -47 feet COP elevation.
4. Waste characterization and barge dewatering samples will be collected from one vertically composited sample from existing mudline to the DOC, which will be estimated based on visual and olfactory indications of contamination.
5. Porewater samples will be collected from 4 to 6 feet below mudline unless PTW-NAPL is observed in that interval. If PTW-NAPL is observed, a new interval will be determined in the field.

COP: City of Portland datum
DOC: depth of contamination
NAPL: nonaqueous phase liquid
PTW: principal threat waste
TBD: to be determined

Table A-7
Sample Handling and Storage

Parameter	Sample Size	Container Size and Type[1]	Holding Time	Sample Preservation Technique	Laboratory
Moisture content	100 g	1 to 4 gallons in zip-top bags	None	None	GTX
Specific gravity	100 g		None	None	
Atterberg limits	100 g		None	None	
Grain size	100 g		None	None	
Bulk density	300 g	Shelby tubes	None	None	
Unconsolidated undrained (UU) triaxial	100 g		None	None	
Consolidated undrained (CU) triaxial	100 g		None	None	
Consolidated drained triaxial	100 g		None	None	
1-D consolidation	100 g		None	None	
Direct shear	100 g		None	None	
SICT	100 g	16-oz glass or HDPE	None	None	University of Colorado
Total solids	50 g	16-oz glass	None	Cool <6°C	All
Total organic carbon	50 g		28 days	Cool <6°C	Apex
			6 months	Freeze -18°C	
Cyanide	50 g		14 days	Cool 2 to 6°C	
Metals	5 g		180 days	Cool <6°C	
VOCs	5 g	40-mL VOA vial with PTFE-lined septum caps (3x)	14 days	Cool 2 to 6°C/$NaHSO_4$ (two vials)/ MeOH (one vial)	
SVOCs, PAHs, PCB Aroclors, pesticides, herbicides, DRO	200 g	16-oz glass	14 days until extraction	Cool <6°C	
			1 year until extraction	Freeze -18°C	
			40 days after extraction	Cool <6°C	
TCLP metals	100 g	8-oz glass	180 days to TCLP extraction	Cool <6°C	
			180 days to analysis	HNO_3 to pH <2	
TCLP SVOCs, pesticides	300 g	2 x 16-oz glass	14 days to TCLP extraction	Cool <2 to 6°C	
			7 days to extraction		
			40 days after extraction		
TCLP VOCs	100 g	4-oz glass, no headspace	14 days to TCLP extraction	Cool <6°C	
			14 days to analysis	HCl to pH <2	
DRET pH	5 gallons sediment + 10 gallons water	Sediment bags and cubitainers	14 days to DRET extraction	Ambient	WST/Apex/Alpha
			Analyze immediately	Cool <2 to 6°C	
DRET TSS			7 days to DRET extraction	Ambient	
			7 days to analysis	Cool <2 to 6°C	
DRET VOCs			14 days to DRET extraction	Ambient	
			14 days to analysis	HCl to pH <2	
DRET SVOCs, pesticides, herbicides, PCBs, TBTs			14 days to DRET extraction	Ambient	
			7 days to extraction	Cool <2 to 6°C	
			40 days after extraction		
DRET metals			180 days to DRET extraction	Ambient	
			180 days to analysis	HNO_3 to pH <2	
DRET dioxin/furans			1 year to DRET extraction	Ambient	
			1 year to analysis	Cool <2 to 6°C	
PCB congeners	30 g	4-oz glass	None	Cool <6°C/freeze -18°C	Vista
Dioxin/furans and HR pesticides			1 year to extraction	Freeze -18°C	
			1 year after extraction		
Organotins	150 g	8-oz glass	14 days until extraction	Cool <6°C	ARI
			1 year until extraction	Freeze -18°C	
			40 days after extraction	Cool <6°C	
PAHs/alkylated PAHs/Biomarkers/SHCs	100 g	4-oz glass	14 days until extraction	Cool <6°C	Alpha
			1 year until extraction	Freeze -18°C	
			40 days after extraction	Cool <6°C	
Perchlorate	50 g	8-oz glass	28 days to extraction, 28 days after extraction	Cool <6°C	
COD	10 g		28 days	Cool <6°C	
pH, ignitability	25 g		14 days	Cool 2 to 6°C	
TCLP Herbicides	300 g	2 x 16-oz glass	14 days to TCLP extraction	Cool <2 - 6°C	
			7 days to extraction		
			40 days after extraction		
Core slabbing and preparation	--	Undisturbed core sections	None	Cool <6°C	Core Labs
Core photography with white light and UV	--	Undisturbed core sections	None	Cool <6°C	
Grain density	--	Undisturbed core sections	None	Cool <6°C	
Porosity	--	Undisturbed core sections	None	Cool <6°C	
Vertical permeability	--	Undisturbed core sections	None	Cool <6°C	
Capillary pressure	--	Undisturbed core sections	None	Cool <6°C	
Free product mobility via centrifuge	--	Undisturbed core sections	None	Cool <6°C	
Pore fluid saturations (NAPL and water)	--	Undisturbed core sections	None	Cool <6°C	

Table A-7
Sample Handling and Storage

Parameter	Sample Size	Container Size and Type[1]	Holding Time	Sample Preservation Technique	Laboratory
Dry bulk density	--	--	--	--	PTS
Hydraulic conductivity	--	--	--	--	
Fluid density, specific gravity	50 mL[2]	2 x 40-mL VOA vial	None	Ambient	
NAPL viscosity			None	Ambient	
NAPL interfacial tension			None	Ambient	
Wettability (droplet method)			None	Ambient	
Water					
TSS	1 L	1-L HDPE	4 days	Cool 2 to 6°C	Apex
Total organic carbon	10 mL	2 x 40-mL VOA vial	28 days	2 to 6°C; H_2SO_4 to pH <2	
Dissolved organic carbon	10 mL	2 x 40-mL VOA vial	28 days	Field Filtered;2 to 6°C; H_2SO_4 to pH <2	
Cyanide	100 mL	1 x 125-mL brown HDPE with NaOH and 125-mL unpreserved	14 days	Cool 2 to 6°C; NaOH to pH >12	
Metals	100 mL	500-mL HDPE	180 days	Cool 2 to 6°C; HNO_3 to pH <2	
pH	10 mL	250-mL HDPE	ASAP	Cool 2 to 6°C	
VOCs	5 mL	40-mL VOA vial with PTFE-lined septum caps (3x)	14 days	Cool 4 to 6°C/HCl to pH <2	
SVOCs	1 L	2 x 1-L amber glass	7 days until extraction	Cool 2 to 6°C	
			40 days after extraction		
PAHs	1L	2 x 1-L amber glass	7 days until extraction	Cool 2 to 6°C	
			40 days after extraction		
Pesticides	1 L	2 x 1-L amber glass	7 days until extraction	Cool 2 to 6°C	
			40 days after extraction		
PCB Aroclors	1 L	2 x 1-L amber glass	14 days until extraction	Cool 2 to 6°C	
			40 days after extraction		
Sheen Nets					
Total petroleum hydrocarbons	1 net	8-oz glass	No established hold time to extraction	Cool 2 to 6°C	Alpha
			40 days after extraction		

Notes:
1. Container size, type, and sample size required may change based on laboratory guidance.
2. More or less may be sent for analysis, depending on volume available.
--: not applicable
ARI: Analytical Resources, Inc.
ASAP: as soon as possible
BOD: biochemical oxygen demand
COD: chemical oxygen demand
DRET: Dredged Elutriate Testing
DRO: diesel range organic
EPH: extractable petroleum hydrocarbon
g: gram
GTX: Geotesting Express
H_2SO_4: sulfuric acid
HCl: hydrochloric acid
HDPE: high-density polyethylene
HNO_3: nitric acid
HR: high resolution
L: liter
MeOH: methanol
mL: milliliter
$NaHSO_4$: sodium bisulfate
NaOH: sodium hydroxide
NAPL: nonaqueous phase liquid
oz: ounce
PAH: polycyclic aromatic hydrocarbon
PCB: polychlorinated biphenyl
PTFE: polytetrafluoroethylene (Teflon)
SICT: seepage induced consolidation test
SVOC: semivolatile organic compound
TBT: tributyltin
TCLP: toxicity characteristic leaching procedure
TSS: total suspended solids
UV: ultraviolet
VOA: volatile organic analysis
VOC: volatile organic compound
WST: Waste Stream Technology

Table A-8
Chemical and Physical Analytes by Sampling Task

Chemical and Physical Analyses		Surface Sediments			Subsurface Sediments								
Analyte Group	Analytes	Surface Grabs	Depositional Surface Grabs	River Bank Boring Soil	DOC	Cap Model Testing	Waste Charaterization	Barge Dewatering	NAPL Mobility Testing	Biogas Generation Potential	Extracted NAPL	Additional Analyses – Non-PAH Analytes	Additional Analyses – PAH Extended
Geotechnical	Analytes vary by sampling task—see QAPP for complete analyte lists	X	X	X	X	X			X	X			
Conventionals	TS and TOC	X	X	X	X	X			X				
Conventionals	List deviates from TS and TOC—see QAPP for complete analyte lists						X	X		X			
Conventionals	Dissolved Organic Carbon												
Metals	Analytes vary by sampling task—see QAPP for complete analyte lists		X	X		X	X	X					
VOCs (µg/kg)	Analytes vary by sampling task—see QAPP for complete analyte lists			X		X	X	X					
PAHs	Sixteen EPA priority pollutant PAHs and 2-methylnaphthalene	X	X	X	X	X							
PAHs and Alkylated PAHs	See QAPP for analyte list								X	X			X
SVOCs	Analytes vary by sampling task—see QAPP for complete analyte lists		X	X		X	X	X					
PCB	PCB-001 209	X	X										
PCB Aroclors	Aroclors 1016, 1221, 1232, 1242, 1248, 1254, 1260, 1262, and 1268			X	X			X				X	
Dioxin/furans	Seventeen 2,3,7,8-substituted congeners	X	X	X	X							X	
Low-resolution pesticides	Six DDx congeners	X			X		X	X				X	
High-resolution pesticides	Six DDx congeners; aldrin, cis-chlordane, trans-chlordane, oxychlordane, cis-nonachlor, trans-nonachlor, dieldrin, lindane		X	X									
TPH	Diesel range organics		X	X									
TPH	TPH(C9-C44)									X	X		X
Saturated hydrocarbons	N/A									X			X
Petroleum biomarkers	N/A												X
Organometallics (µg/kg)	Tributyltin		X	X									
Herbicides	2,4-D, 2,4,5-TP (silvex)						X						
TCLP Metals	See QAPP for analyte list						X						
TCLP VOCs	See QAPP for analyte list						X						
TCLP SVOCs	See QAPP for analyte list						X						
TCLP Pesticides	See QAPP for analyte list						X						
TCLP Herbicides	See QAPP for analyte list						X						
NAPL Mobility Testing	See QAPP for analyte list								X				

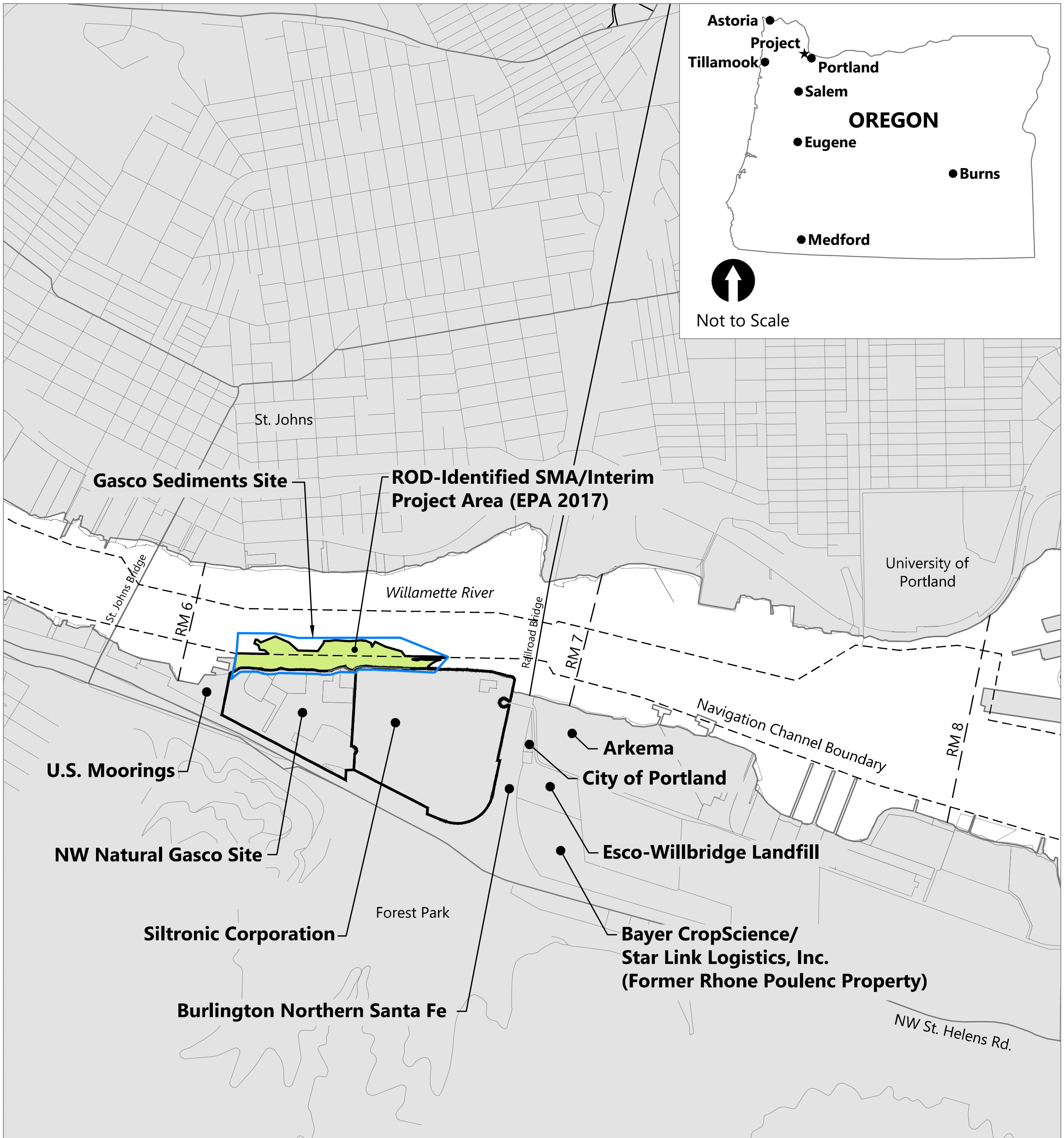
Notes:
µg/kg: micrograms per kilogram
DDx: 2,4′ and 4,4′-DDD, -DDE, -DDT
DOC: depth of contamination
EPA: U.S. Environmental Protection Agency
MCPP: methylchlorophenoxypropionic acid
N/A: not applicable
NAPL: nonaqueous phase liquid
PAH: polycyclic aromatic hydrocarbon
PCB: polychlorinated biphenyl
QAPP: Quality Assurance Project Plan
SVOC: semivolatile organic compound
TCLP: toxicity characteristic leaching procedure
TOC: total organic carbon
TPH: total petroleum hydrocarbons
TS: total solid
VOC: volatile organic compound

Table A-8
Chemical and Physical Analytes by Sampling Task

Chemical and Physical Analyses		Paired Sampling for Equilibrium Partition Coefficient Development		Subsurface Samples in PTW-NAPL		
Analyte Group	**Analytes**	**Subsurface Sediment**	**Porewater**	**Porewater**	**Ebullition Sheen**	**Geotechnical**
Geotechnical	Analytes vary by sampling task—see QAPP for complete analyte lists					X
Conventionals	TS and TOC	X				
Conventionals	List deviates from TS and TOC—see QAPP for complete analyte lists					
Conventionals	Dissolved Organic Carbon		X	X		
Metals	Analytes vary by sampling task—see QAPP for complete analyte lists					
VOCs (µg/kg)	Analytes vary by sampling task—see QAPP for complete analyte lists	X	X	X		
PAHs	Sixteen EPA priority pollutant PAHs and 2-methylnaphthalene			X		
PAHs and Alkylated PAHs	See QAPP for analyte list					
SVOCs	Analytes vary by sampling task—see QAPP for complete analyte lists					
PCB	PCB-001 209					
PCB Aroclors	Aroclors 1016, 1221, 1232, 1242, 1248, 1254, 1260, 1262, and 1268					
Dioxin/furans	Seventeen 2,3,7,8-substituted congeners					
Low-resolution pesticides	Six DDx congeners					
High-resolution pesticides	Six DDx congeners; aldrin, cis-chlordane, trans-chlordane, oxychlordane, cis-nonachlor, trans-nonachlor, dieldrin, lindane					
TPH	Diesel range organics				X	
TPH	TPH(C9-C44)				X	
Saturated hydrocarbons	N/A					
Petroleum biomarkers	N/A					
Organometallics (µg/kg)	Tributyltin					
Herbicides	2,4-D, 2,4,5-TP (silvex)					
TCLP Metals	See QAPP for analyte list					
TCLP VOCs	See QAPP for analyte list					
TCLP SVOCs	See QAPP for analyte list					
TCLP Pesticides	See QAPP for analyte list					
TCLP Herbicides	See QAPP for analyte list					
NAPL Mobility Testing	See QAPP for analyte list					

Notes:
µg/kg: micrograms per kilogram
DDx: 2,4′ and 4,4′-DDD, -DDE, -DDT
DOC: depth of contamination
EPA: U.S. Environmental Protection Agency
MCPP: methylchlorophenoxypropionic acid
N/A: not applicable
NAPL: nonaqueous phase liquid
PAH: polycyclic aromatic hydrocarbon
PCB: polychlorinated biphenyl
QAPP: Quality Assurance Project Plan
SVOC: semivolatile organic compound
TCLP: toxicity characteristic leaching procedure
TOC: total organic carbon
TPH: total petroleum hydrocarbons
TS: total solid
VOC: volatile organic compound

Figures



HORIZONTAL DATUM: Oregon State Plane North, North American Datum (NAD83/HARN 91), International Feet.

NOTE: All locations are approximate.

Publish Date: 2019/08/21 7:54 AM | User: hmerrick
Filepath: K:\Projects\0029-NW Natural Gas Co\Gasco Sediments_Pre-Remedial Design\Pre_RD Data Gaps Field Sampling Plan\0029-RP-001 (Vicinity Map).dwg Figure A-1

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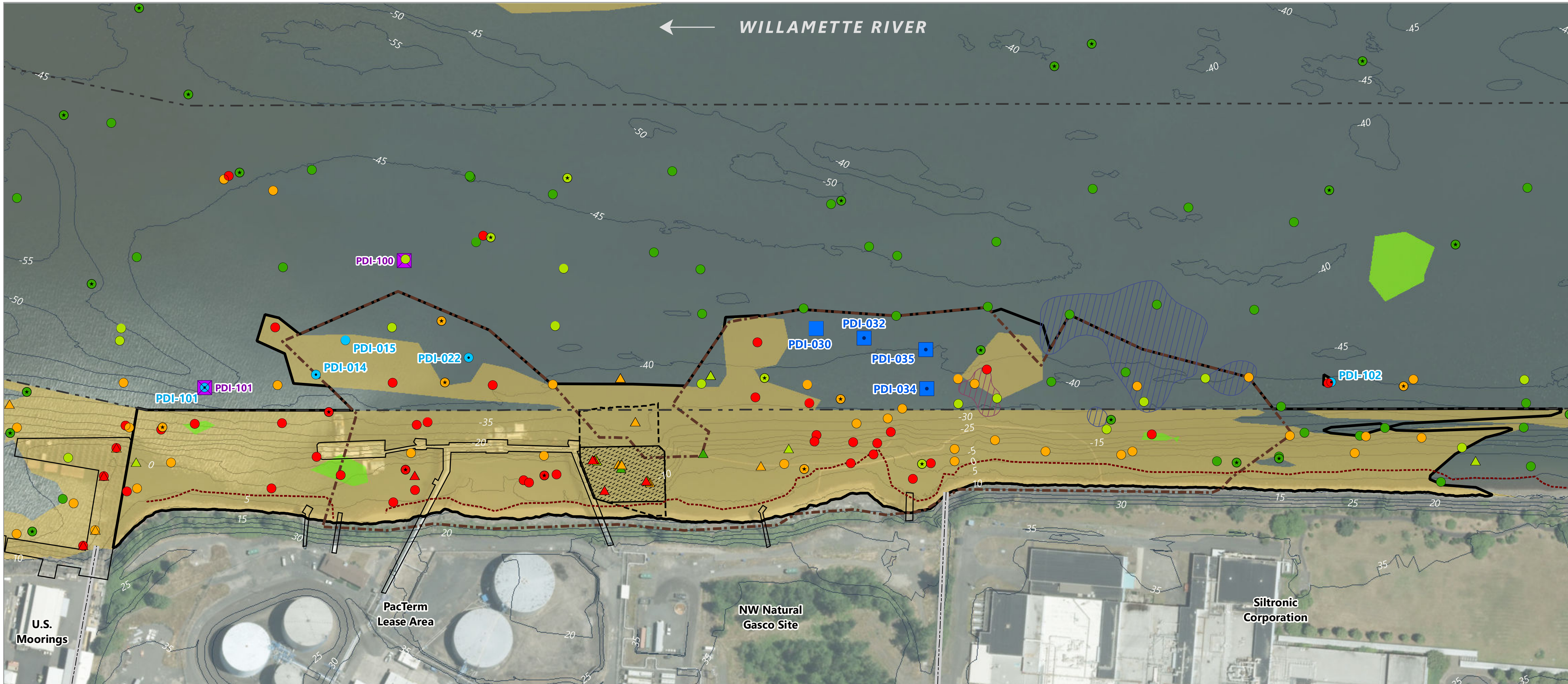
Figure A-1
Vicinity Map

Pre-Remedial Design Data Gaps Field Sampling Plan
Gasco Sediments Cleanup Action



LEGEND:

- Navigation Channel
- Structures
- Property Line
- Tar Body Removal Action Area (RAPP, Anchor 2005)
- Tar Body Removal Action Pilot Cap
- PTW-NAPL Boundary
- Elevation (feet COP)
- Approximate Riprap Boundary[1]
- ROD-Identified SMAs (EPA 2017) Included in the Ga sco Sedim ent Site Interim Project Area[2]
- Total Area Exceeding ROD Table 21 Focused COC RALs and PTW-Highly Toxic Additional Contaminant Thresholds[3]
- Total PCB PTW-Highly Toxic Additional Contaminant Threshold Exceedance
- 2010 Transition Zone Water Vinyl Chloride Area 1 Boundary (Anchor QEA 2012)[4]
- Area 2 – Detected CVOCs in TZW and One Subsurface Sediment Location[5]

Total PAH (µg/kg)

- ≤ ROD RAL (13,000)
- > ROD RAL (13,000) and ≤ ROD RAL ESD (30,000)
- > ROD RAL ESD (30,000) and ≤ Nav ROD RAL (170,000)
- > Nav ROD RAL (170,000)

- Pre-RD Group Harborwide Monitoring Surface Sample Location (AECOM and Geosyntec 2018a)
- Surface Sample Locations Not Included in the ROD
- Surface Sample Location Included in the ROD
- Proposed Interim Project Area Verification Surface Sediment Grab
- Proposed 0- to 1-Foot Interval For Additional Surface Sediment Concentration Data Density
- Proposed 1-2 ft, 2-3 ft, and 3-4 ft Interim Project Area Refinement Subsurface Sample Locations

NOTES:

1. Estimated from side scan sonar survey conducted by Blue Water Engineering April 2011.
2. All depicted SMA technology and PTW contours taken from the Portland Harbor Superfund Site Record of Decision (2017) without application of the EPA Explanation of Significant Differences (ESD; EPA 2018), which is not yet finalized.
3. Total area determined based on exceedances of ROD Table 21 focused COC RALs and PTW-highly toxic additional contaminant thresholds. Does not account for ESD, which is still undergoing public review and comment.
4. Boundary taken from Draft Engineering Evaluation/Cost Analysis, Appendix A, Figure 4.2. Transition zone water screening level exceedances of cis-1,2-dichloroethene identified within this vinyl chloride boundary.
5. Boundary taken from Gasco Sediments Site Statement of Work, Figure 1 (EPA 2009).
6. Bathymetry surveyed by DEA 2018. Topography surveyed by Geometrix 2011.
7. Arrow indicates direction of flow of river.
8. Horizontal datum is NAD83 (HARN 91) Oregon State Plane North, International Feet.
9. Vertical datum is City of Portland (COP), Feet.
10. Aerial imagery from City of Portland 2016.

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Figure A-2
Proposed Interim Project Area Refinement Sampling Locations
Pre-Remedial Design Data Gaps Field Sampling Plan
Gasco Sediments Cleanup Action

LEGEND:

- Navigation Channel
- Structures
- Property Line
- Tar Body Removal Action Area (RAPP, Anchor 2005)
- Tar Body Removal Action Pilot Cap
- PTW-NAPL Boundary
- Elevation (feet COP)
- Approximate Riprap Boundary[1]

ROD SMA Technology[2]

- Cap
- Dredge
- Dredge in Nav-FMD
- Dredge with Cap
- 2010 Transition Zone Water Vinyl Chloride Area 1 Boundary (Anchor QEA 2012)[3]
- Area 2 – Detected CVOCs in TZW and One Subsurface Sediment Location[4]

- Extent of DNAPL Deemed Potentially Mobile Identified in Interim Feasibility Study (Anchor QEA 2018b; 0 to 12 feet)
- Extent of DNAPL Deemed Potentially Mobile Identified in Interim Feasibility Study (Anchor QEA 2018b; 12 to 22 feet)
- Existing Cores with Previously Observed PTW-NAPL
- Existing Subsurface Sample Location
- Soil Boring
- Top of Riverbank Borings[5]
- Proposed Angled Top of Riverbank Boring[6]
- Extent of Armored Siltronic Riverbank

NOTES:

1. Estimated from side scan sonar survey conducted by Blue Water Engineering April 2011.
2. All depicted SMA technology and PTW contours taken from the Portland Harbor Superfund Site Record of Decision (2017) without application of the EPA Explanation of Significant Differences (ESD; EPA 2018), which is not yet finalized.
3. Boundary taken from Draft Engineering Evaluation/Cost Analysis, Appendix A, Figure 4.2. Transition zone water screening level exceedances of cis-1,2-dichloroethene identified within this vinyl chloride boundary.
4. Boundary taken from Gasco Sediments Site Statement of Work, Figure 1 (EPA 2009).
5. Top of riverbank borings collected in 2009 to support sediment remedy evaluation of subsurface soil concentrations and disposal suitability.
6. The locations may need to be adjusted in the field as necessary to facilitate equipment access.
7. Arrow indicates direction of flow of river.
8. Horizontal datum is NAD83 (HARN 91) Oregon State Plane North, International Feet.
9. Vertical datum is City of Portland (COP), Feet.
10. Aerial imagery from City of Portland 2016.

6. Bathymetry surveyed by DEA 2018. Topography surveyed by Geometrix 2011.

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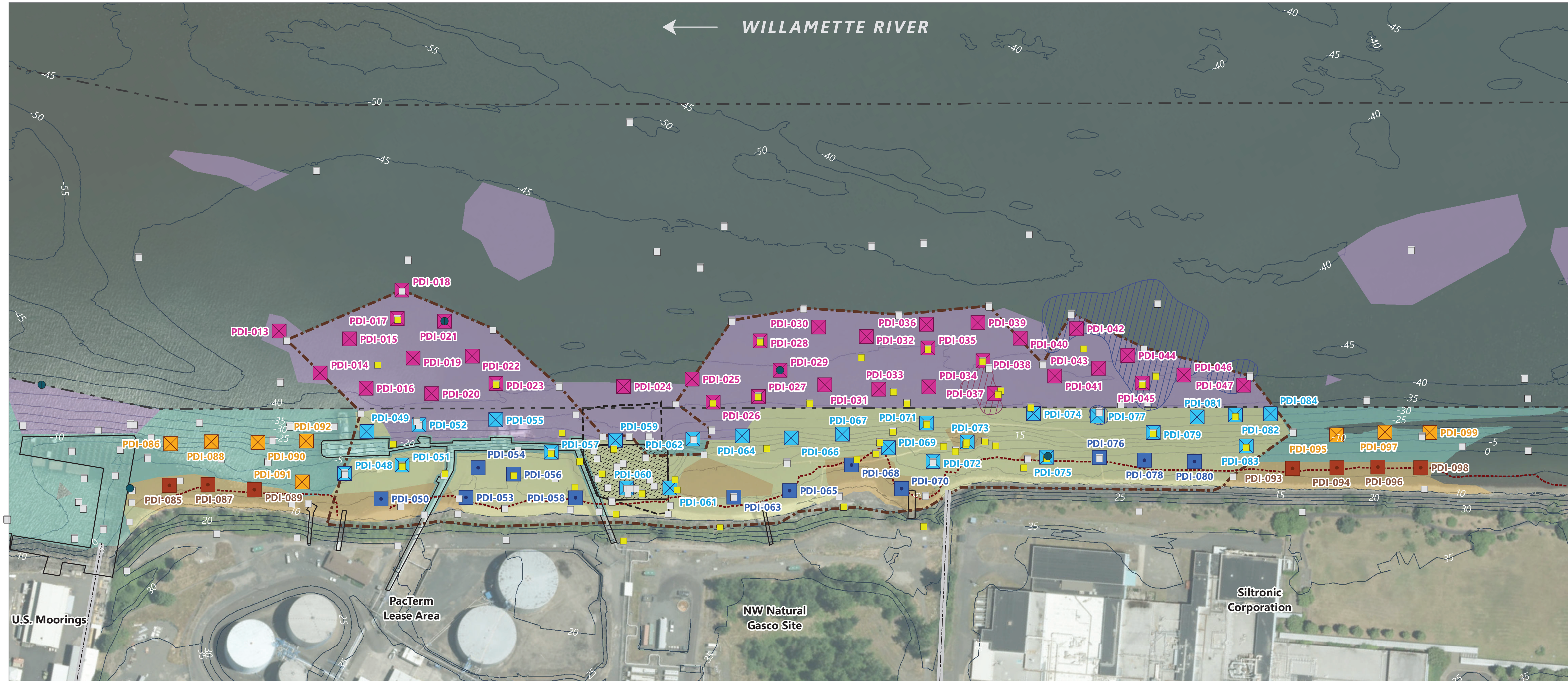
Figure A-3
Proposed Angled Top of Riverbank Borings
Pre-Remedial Design Data Gaps Field Sampling Plan
Gasco Sediments Cleanup Action



LEGEND:

- Navigation Channel
- Structures
- Property Line
- Tar Body Removal Action Area (RAPP, Anchor 2005)
- Tar Body Removal Action Pilot Cap
- PTW-NAPL Boundary
- Elevation (feet COP)
- Approximate Riprap Boundary[1]

ROD SMA Technology[2]

- Cap
- Dredge
- Dredge in Nav-FMD
- Dredge with Cap
- 2010 Transition Zone Water Vinyl Chloride Area 1 Boundary (Anchor QEA 2012)[3]
- Area 2 – Detected CVOCs in TZW and One Subsurface Sediment Location[4]

- Pre-RD Group Harborwide Monitoring Subsurface Sample Location (AECOM and Geosyntec 2018a)
- Existing Cores with Previously Observed PTW-NAPL
- Existing Subsurface Sample Location

Proposed Capping Only Cores

- Consecutive 2-ft Intervals Throughout Core Penetration Depth
- 0-2 ft, 2-5 ft, 5-7 ft, 7-10 ft, and 10-13 ft Intervals[5,6]

Proposed Dredge and Cap Cores[7]

- Consecutive 2-ft Intervals Throughout Core Penetration Depth
- 0-2 ft, 2-5 ft, 5-7 ft, 7-10 ft, and 10-13 ft Intervals[5,6]
- Consecutive 2-ft Intervals Throughout Core Penetration Depth Initiating at -47 Feet COP Elevation[8]

NOTES:

1. Estimated from from side scan sonar survey conducted by Blue Water Engineering April 2011.
2. All depicted SMA technology and PTW contours taken from the Portland Harbor Superfund Site Record of Decision (2017) without application of the EPA Explanation of Significant Differences (ESD; EPA 2018), which is not yet finalized.
3. Boundary taken from Draft Engineering Evaluation/Cost Analysis, Appendix A, Figure 4.2. Transition zone water screening level exceedances of cis-1,2-dichloroethene identified within this vinyl chloride boundary.
4. Boundary taken from Gasco Sediments Site Statement of Work, Figure 1 (EPA 2009).
5. Potentially deeper samples will be collected if PTW-NAPL is identified. NAPL mobility testing may be conducted based on PTW-NAPL observations in deeper intervals.
6. The nearshore core locations may need to be adjusted further offshore depending on the river elevations during sample collection to facilitate vessel access.
7. All dredge and cap core locations are identical to DOC locations shown in Figure 5.
8. Capping in the channel becomes feasible in the navigation channel below -47 feet COP, based on ROD-identified -43 feet Columbia River Datum (CRD) authorized federal maintenance dredging elevation plus 3 feet overdredge plus 4- to 5-foot underlying cap thickness plus conversion from CRD to COP datum.
9. Bathymetry surveyed by DEA 2018. Topography surveyed by Geometrix 2011.
10. Arrow indicates direction of flow of river.
11. Horizontal datum is NAD83 (HARN 91) Oregon State Plane North, International Feet.
12. Vertical datum is City of Portland (COP), Feet.
13. Aerial imagery from City of Portland 2016.

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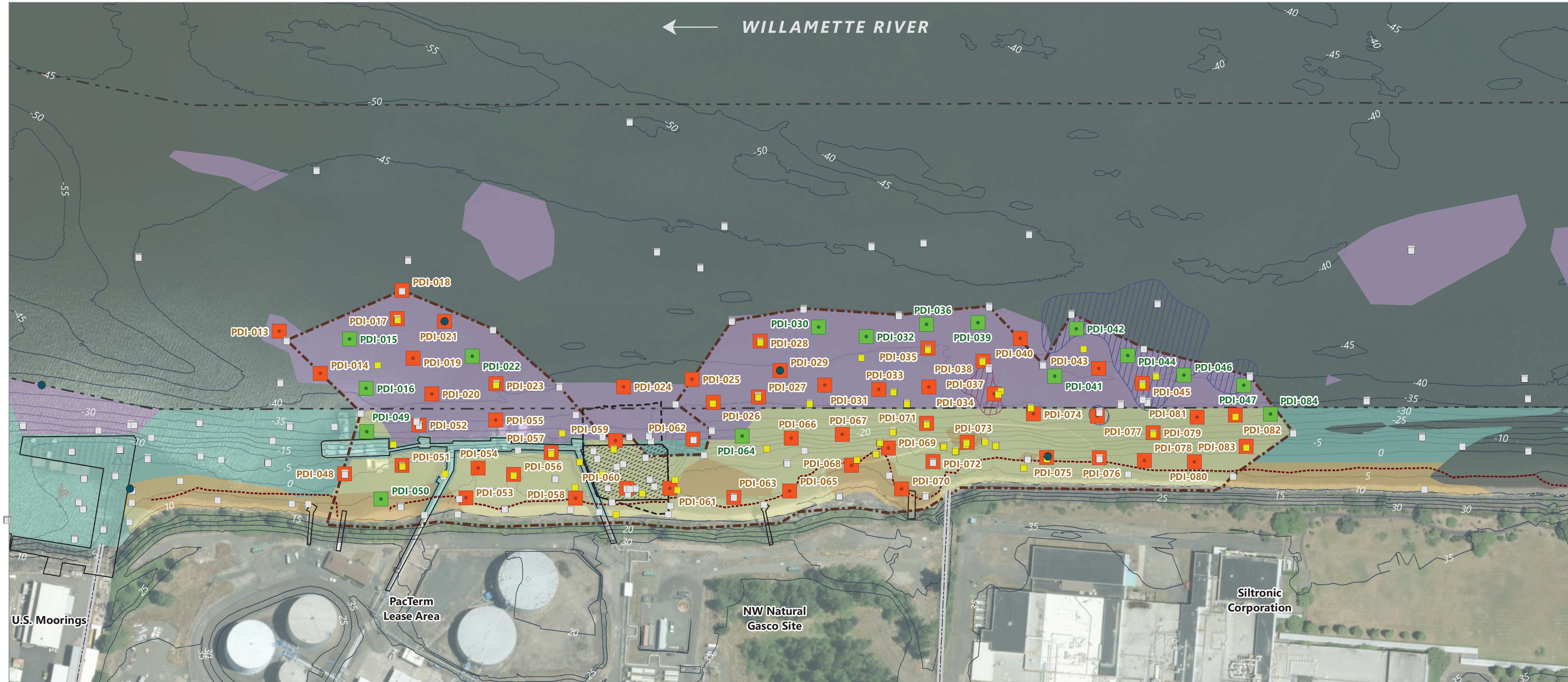
Figure A-4
Proposed Subsurface Capping Demonstration Cores
Pre-Remedial Design Data Gaps Field Sampling Plan
Gasco Sediments Cleanup Action



LEGEND:

- Navigation Channel
- Structures
- Property Line
- Tar Body Removal Action Area (RAPP, Anchor 2005)
- Tar Body Removal Action Pilot Cap
- PTW-NAPL Boundary
- Elevation (feet COP)
- Approximate Riprap Boundary[1]

ROD SMA Technology[2]

- Cap
- Dredge
- Dredge in Nav-FMD
- Dredge with Cap
- 2010 Transition Zone Water Vinyl Chloride Area 1 Boundary (Anchor QEA 2012)[3]
- Area 2 – Detected CVOCs in TZW and One Subsurface Sediment Location[4]

- Pre-RD Group Harborwide Monitoring Subsurface Sample Location (AECOM and Geosyntec 2018a)
- Existing Cores with Previously Observed PTW-NAPL
- Existing Subsurface Sample Location
- Proposed DOC Core[5]
- Proposed DOC and PTW-NAPL Refinement Core

NOTES:

1. Estimated from side scan sonar survey conducted by Blue Water Engineering April 2011.
2. All depicted SMA technology and PTW contours taken from the Portland Harbor Superfund Site Record of Decision (2017) without application of the EPA Explanation of Significant Differences (ESD; EPA 2018), which is not yet finalized.
3. Boundary taken from Draft Engineering Evaluation/Cost Analysis, Appendix A, Figure 4.2. Transition zone water screening level exceedances of cis-1,2-dichloroethene identified within this vinyl chloride boundary.
4. Boundary taken from Gasco Sediments Site Statement of Work, Figure 1 (EPA 2009).
5. The nearshore core locations may need to be adjusted further offshore depending on the river elevations during sample collection to facilitate vessel access.
6. Bathymetry surveyed by DEA 2018. Topography surveyed by Geometrix 2011.
7. Arrow indicates direction of flow of river.
8. Horizontal datum is NAD83 (HARN 91) Oregon State Plane North, International Feet.
9. Vertical datum is City of Portland (COP), Feet.
10. Aerial imagery from City of Portland 2016.

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Figure A-5

Proposed Subsurface Depth of Contamination and PTW-NAPL Boundary Refinement Cores

Pre-Remedial Design Data Gaps Field Sampling Plan
Gasco Sediments Cleanup Action

LEGEND:

- Navigation Channel
- Structures
- Property Line
- Tar Body Removal Action Area (RAPP, Anchor 2005)
- Tar Body Removal Action Pilot Cap
- PTW-NAPL Boundary
- Elevation (feet COP)
- Approximate Riprap Boundary[1]

ROD SMA Technology[2]

- Cap
- Dredge
- Dredge in Nav-FMD
- Dredge with Cap
- 2010 Transition Zone Water Vinyl Chloride Area 1 Boundary (Anchor QEA 2012)[3]
- Area 2 – Detected CVOCs in TZW and One Subsurface Sediment Location[4]

- Pre-RD Group Harborwide Monitoring Subsurface Sample Location (AECOM and Geosyntec 2018a)
- Existing Cores with Previously Observed PTW-NAPL
- Existing Subsurface Sample Location
- Barge Dewatering Treatment and Stabilization Evaluation Core

NOTES:

1. Estimated from side scan sonar survey conducted by Blue Water Engineering April 2011.
2. All depicted SMA technology and PTW contours taken from the Portland Harbor Superfund Site Record of Decision (2017) without application of the EPA Explanation of Significant Differences (ESD; EPA 2018), which is not yet finalized.
3. Boundary taken from Draft Engineering Evaluation/Cost Analysis, Appendix A, Figure 4.2. Transition zone water screening level exceedances of cis-1,2-dichloroethene identified within this vinyl chloride boundary.
4. Boundary taken from Gasco Sediments Site Statement of Work, Figure 1 (EPA 2009).
5. Bathymetry surveyed by DEA 2018. Topography surveyed by Geometrix 2011.
6. Arrow indicates direction of flow of river.
7. Horizontal datum is NAD83 (HARN 91) Oregon State Plane North, International Feet.
8. Vertical datum is City of Portland (COP), Feet.
9. Aerial imagery from City of Portland 2016.

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Figure A-6
Proposed Dredge Material Barge Dewatering Treatment and Stabilization Evaluation Cores
Pre-Remedial Design Data Gaps Field Sampling Plan
Gasco Sediments Cleanup Action

LEGEND:

- Navigation Channel
- Structures
- Property Line
- Tar Body Removal Action Area (RAPP, Anchor 2005)
- Tar Body Removal Action Pilot Cap
- PTW-NAPL Boundary
- Elevation (feet COP)
- Approximate Riprap Boundary[1]

ROD SMA Technology[2]

- Cap
- Dredge
- Dredge in Nav-FMD
- Dredge with Cap
- 2010 Transition Zone Water Vinyl Chloride Area 1 Boundary (Anchor QEA 2012)[3]
- Area 2 – Detected CVOCs in TZW and One Subsurface Sediment Location[4]

- Pre-RD Group Harborwide Monitoring Subsurface Sample Location (AECOM and Geosyntec 2018a)
- Existing Cores with Previously Observed PTW-NAPL
- Existing Subsurface Sample Location
- Existing TCLP Location
- Proposed TCLP/RBC Location

NOTES:

1. Estimated from side scan sonar survey conducted by Blue Water Engineering April 2011.
2. All depicted SMA technology and PTW contours taken from the Portland Harbor Superfund Site Record of Decision (2017) without application of the EPA Explanation of Significant Differences (ESD; EPA 2018), which is not yet finalized.
3. Boundary taken from Draft Engineering Evaluation/Cost Analysis, Appendix A, Figure 4.2. Transition zone water screening level exceedances of cis-1,2-dichloroethene identified within this vinyl chloride boundary.
4. Boundary taken from Gasco Sediments Site Statement of Work, Figure 1 (EPA 2009).
5. Bathymetry surveyed by DEA 2018. Topography surveyed by Geometrix 2011.
6. Arrow indicates direction of flow of river.
7. Horizontal datum is NAD83 (HARN 91) Oregon State Plane North, International Feet.
8. Vertical datum is City of Portland (COP), Feet.
9. Aerial imagery from City of Portland 2016.

TCLP: toxicity characteristic leaching procedure
RBC: risk-based concentration

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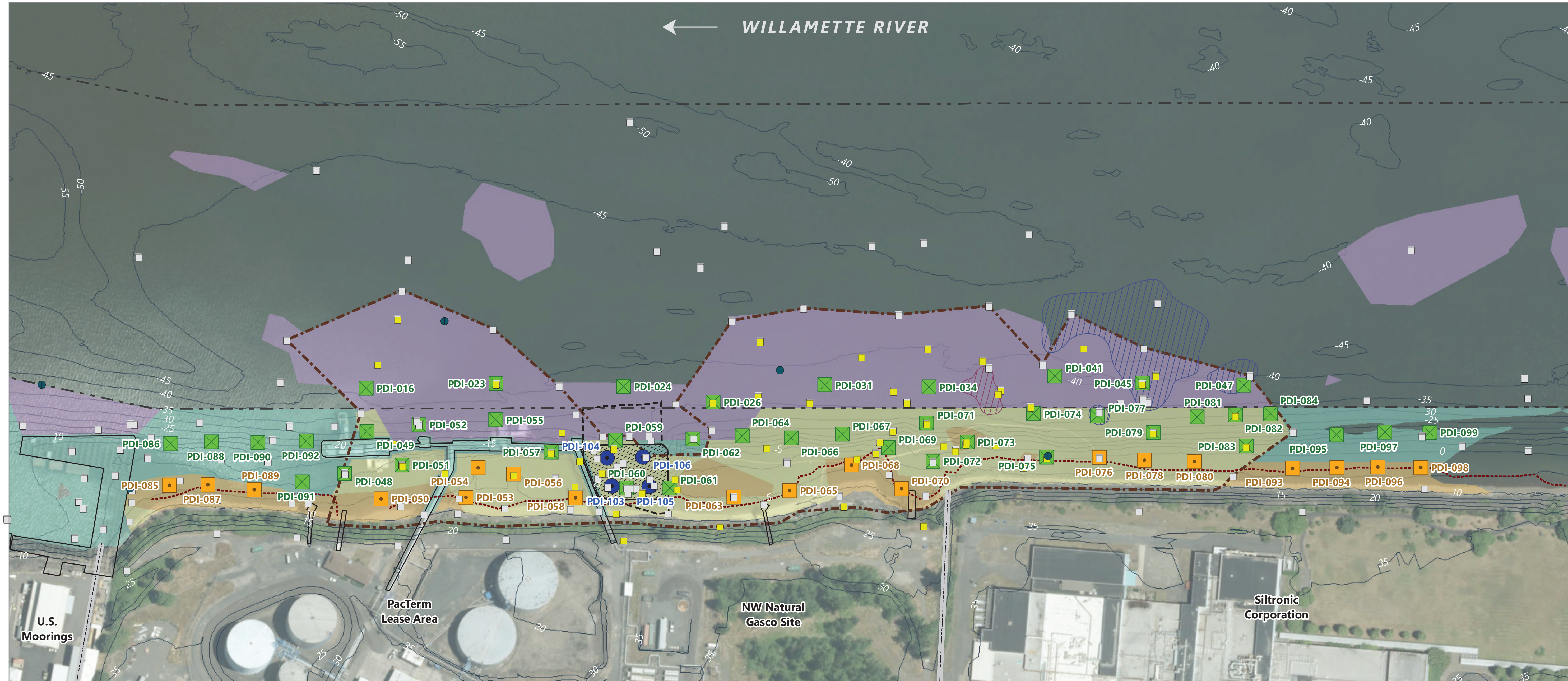
Figure A-7
Proposed Dredge Material and Riverbank Waste Suitability Characterization Cores and Borings
Pre-Remedial Design Data Gaps Field Sampling Plan
Gasco Sediments Cleanup Action



LEGEND:

- Navigation Channel
- Structures
- Property Line
- Tar Body Removal Action Area (RAPP, Anchor 2005)
- Tar Body Removal Action Pilot Cap
- PTW-NAPL Boundary
- Elevation (feet COP)
- Approximate Riprap Boundary[1]

ROD SMA Technology[2]

- Cap
- Dredge
- Dredge in Nav-FMD
- Dredge with Cap
- 2010 Transition Zone Water Vinyl Chloride Area 1 Boundary (Anchor QEA 2012)[3]
- Area 2 – Detected CVOCs in TZW and One Subsurface Sediment Location[4]

- Pre-RD Group Harborwide Monitoring Subsurface Sample Location (AECOM and Geosyntec 2018a)
- Existing Cores with Previously Observed PTW-NAPL
- Existing Subsurface Sample Location

Proposed Additional Analyses Locations

- 0-1 ft
- 0-2 ft, 2-4 ft, 4-6 ft, and 6-8 ft
- 0-2 ft, 2-5 ft, and 5-7 ft[5]

NOTES:

1. Estimated from side scan sonar survey conducted by Blue Water Engineering April 2011.
2. All depicted SMA technology and PTW contours taken from the Portland Harbor Superfund Site Record of Decision (2017) without application of the EPA Explanation of Significant Differences (ESD; EPA 2018), which is not yet finalized.
3. Boundary taken from Draft Engineering Evaluation/Cost Analysis, Appendix A, Figure 4.2. Transition zone water screening level exceedances of cis-1,2-dichloroethene identified within this vinyl chloride boundary.
4. Boundary taken from Gasco Sediments Site Statement of Work, Figure 1 (EPA 2009).
5. The nearshore core locations may need to be adjusted further offshore depending on the river elevations during sample collection to facilitate vessel access.
6. The non-site-specific categorization is based on historical and current operations.
7. Bathymetry surveyed by DEA 2018. Topography surveyed by Geometrix 2011.
8. Arrow indicates direction of flow of river.
9. Horizontal datum is NAD83 (HARN 91) Oregon State Plane North, International Feet.
10. Vertical datum is City of Portland (COP), Feet.
11. Aerial imagery from City of Portland 2016.

0 200
Feet

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Figure A-8
Proposed Additional Analyses Locations for Non-Site-Specific COCs
Pre-Remedial Design Data Gaps Field Sampling Plan
Gasco Sediments Cleanup Action

LEGEND:

- Navigation Channel
- Structures
- Property Line
- Tar Body Removal Action Area (RAPP, Anchor 2005)
- Tar Body Removal Action Pilot Cap
- PTW-NAPL Boundary
- Elevation (feet COP)
- Approximate Riprap Boundary[1]

ROD SMA Technology[2]

- Cap
- Dredge
- Dredge in Nav-FMD
- Dredge with Cap
- 2010 Transition Zone Water Vinyl Chloride Area 1 Boundary (Anchor QEA 2012)[3]
- Area 2 – Detected CVOCs in TZW and One Subsurface Sediment Location[4]

- Cores Less Than 15 Feet Long

Percent Recovery (Cores 15 feet or longer)

- 33% - 50%
- 51% - 60%
- 61% - 70%
- 71% - 80%
- 81% - 100%

NOTES:

1. Estimated from side scan sonar survey conducted by Blue Water Engineering April 2011.
2. All depicted SMA technology and PTW contours taken from the Portland Harbor Superfund Site Record of Decision (2017) without application of the EPA Explanation of Significant Differences (ESD; EPA 2018), which is not yet finalized.
3. Boundary taken from Draft Engineering Evaluation/Cost Analysis, Appendix A, Figure 4.2. Transition zone water screening level exceedances of cis-1,2-dichloroethene identified within this vinyl chloride boundary.
4. Boundary taken from Gasco Sediments Site Statement of Work, Figure 1 (EPA 2009).
5. Bathymetry surveyed by DEA 2018. Topography surveyed by Geometrix 2011.
6. Arrow indicates direction of flow of river.
7. Horizontal datum is NAD83 (HARN 91) Oregon State Plane North, International Feet.
8. Vertical datum is City of Portland (COP), Feet.
9. Aerial imagery from City of Portland 2016.

0 200
Feet

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Figure A-9
Percent Recovery of Subsurface Cores Longer than 15 Feet
Pre-Remedial Design Data Gaps Field Sampling Plan
Gasco Sediments Cleanup Action

LEGEND:

- Navigation Channel
- Structures
- Property Line
- Tar Body Removal Action Area (RAPP, Anchor 2005)
- Tar Body Removal Action Pilot Cap
- PTW-NAPL Boundary
- Elevation (feet COP)
- Approximate Riprap Boundary[1]

ROD SMA Technology[2]

- Cap
- Dredge
- Dredge in Nav-FMD
- Dredge with Cap
- 2010 Transition Zone Water Vinyl Chloride Area 1 Boundary (Anchor QEA 2012)[3]
- Area 2 – Detected CVOCs in TZW and One Subsurface Sediment Location[4]

- Existing Cores with Previously Observed PTW-NAPL
- Existing Cores without Observed PTW-NAPL
- Proposed Paired Subsurface and Porewater Sampling Locations

Proposed Biogas Generation Potential Sampling Locations[5,6]

- 6-8 ft Interval
- 5-7 ft Interval

NOTES:

1. Estimated from side scan sonar survey conducted by Blue Water Engineering April 2011.
2. All depicted SMA technology and PTW contours taken from the Portland Harbor Superfund Site Record of Decision (2017) without application of the EPA Explanation of Significant Differences (ESD; EPA 2018), which is not yet finalized.
3. Boundary taken from Draft Engineering Evaluation/Cost Analysis, Appendix A, Figure 4.2. Transition zone water screening level exceedances of cis-1,2-dichloroethene identified within this vinyl chloride boundary.
4. Boundary taken from Gasco Sediments Site Statement of Work, Figure 1 (EPA 2009).
5. Potentially deeper samples will be collected if PTW-NAPL is identified. NAPL mobility testing may be conducted based on PTW-NAPL observations in deeper intervals.
6. The nearshore core locations may need to be adjusted further offshore depending on the river elevations during sample collection to facilitate vessel access.
7. Bathymetry surveyed by DEA 2018. Topography surveyed by Geometrix 2011.
8. Arrow indicates direction of flow of river.
9. Horizontal datum is NAD83 (HARN 91) Oregon State Plane North, International Feet.
10. Vertical datum is City of Portland (COP), Feet.
11. Aerial imagery from City of Portland 2016.

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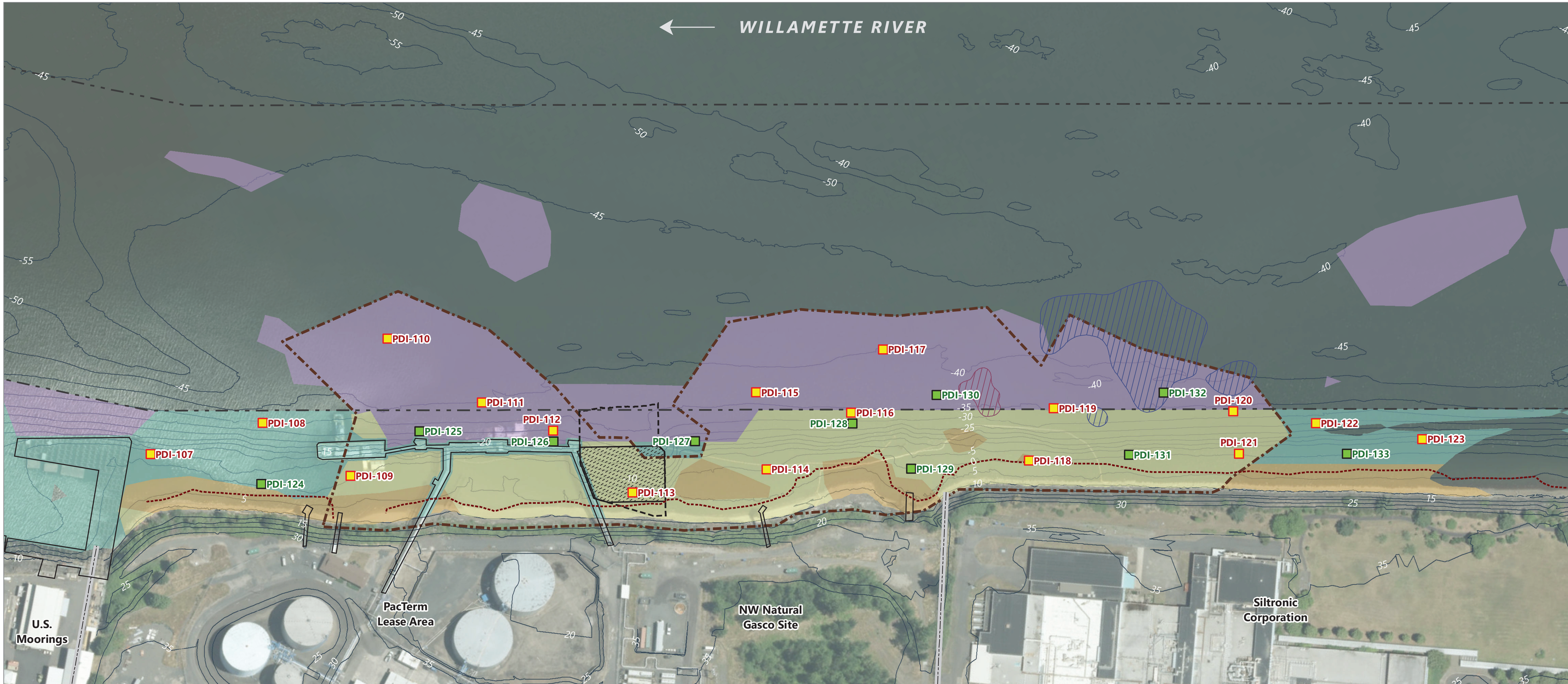
Figure A-10
Proposed Paired Subsurface Sediment and Porewater and Biogas Generation Potential Sampling Locations
Pre-Remedial Design Data Gaps Field Sampling Plan
Gasco Sediments Cleanup Action



LEGEND:

- Navigation Channel
- Structures
- Property Line
- Tar Body Removal Action Area (RAPP, Anchor 2005)
- Tar Body Removal Action Pilot Cap
- PTW-NAPL Boundary
- Elevation (feet COP)
- Approximate Riprap Boundary[1]

ROD SMA Technology[2]

- Cap
- Dredge
- Dredge in Nav-FMD
- Dredge with Cap
- 2010 Transition Zone Water Vinyl Chloride Area 1 Boundary (Anchor QEA 2012)[3]
- Area 2 – Detected CVOCs in TZW and One Subsurface Sediment Location[4]

- Proposed Sonic Core with Standard Penetration Test[5]
- Proposed In Situ Penetration Test[5]

NOTES:

1. Estimated from side scan sonar survey conducted by Blue Water Engineering April 2011.
2. All depicted SMA technology and PTW contours taken from the Portland Harbor Superfund Site Record of Decision (2017) without application of the EPA Explanation of Significant Differences (ESD; EPA 2018), which is not yet finalized.
3. Boundary taken from Draft Engineering Evaluation/Cost Analysis, Appendix A, Figure 4.2. Transition zone water screening level exceedances of cis-1,2-dichloroethene identified within this vinyl chloride boundary.
4. Boundary taken from Gasco Sediments Site Statement of Work, Figure 1 (EPA 2009).
5. The nearshore locations may be adjusted further toward of riverbank depending on the river elevations during sample collection if vessel access allows.
6. Bathymetry surveyed by DEA 2018. Topography surveyed by Geometrix 2011.
7. Arrow indicates direction of flow of river.
8. Horizontal datum is NAD83 (HARN 91) Oregon State Plane North, International Feet.
9. Vertical datum is City of Portland (COP), Feet.
10. Aerial imagery from City of Portland 2016.

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Figure A-11
Proposed Geotechnical Explorations
Pre-Remedial Design Data Gaps Field Sampling Plan
Gasco Sediments Cleanup Action

Attachment A

Field Forms

Field Form - Porewater Sample Collection with Porous-Ceramic Filter

Project:		Date:	☐ QC Sample
Project No:		Location ID:	
Field Staff:		Target Elevation and Depth (ft):	

A. Water Depths

Time:	
Depth to Mudline (ft; measured from top of drill pipe):	
Depth to Water[1] (ft; measured from top of drill pipe):	

Ceramic Filter Deployment Method

Intake Tubing Method	
Discharge Through Filter	

B. Drill Pipe Measurement

Time:	
Pipe Height Above Water (ft; measured to top of drill pipe):	
Total Depth of borehole (ft; measured from top of drill pipe):	

C. Elevation

Mudline[2]:
Water[3]:
Sampler Intake[4]:

D. Sampler Volume

Volume of Ceramic Filter (L)[5]:	
Volume of Tubing Connected to Sampling Pump (L):	
Total Sampler Volume (L):	

Water Quality Instrument Make/Model:				Instrument Serial No.	
Sensor (check applicable parameters)	☐ Temperature	☐ pH	☐ Specific Conductance		
Sensor ID/serial No.	#__________	#_______	#_________	Sampler Intake Depth from top of casing:	

Water Quality Data

Pre-Purge Start Time*:		Sampler Inlet Depth:
Pre-Purge Rate*:		Initial Depth to Water:

Time	Sampling Pump Rate (mL/min)	Purge Pump Rate (mL/min, for dual-pump method only)	Temperature °C	pH	Specific Conductance (µS/cm)	Depth to Water (ft)	Water Quality Notes (i.e. color, odor, clarity)

Sampling ID	Sampling Depth (Below Mudline) (ft)	Sample Time	Analyses

Notes

1. Depth to water should be measured inside of the drill casing left in place to secure the borehole.
2. River Elevation - Leadline = Mudline Elevation
3. River Elevation - (GW Depth - Casing Height Above Water) = Groundwater Elevation.
4. River Elevation - (Total Depth of Borehole – Casing Height Above Water) = Sampler Intake
5. Ceramic sampler volume is approximately 30 mL per inch of filter length.

* For dual-pump porewater sampling from drill casing only

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Sediment Core Collection Log

Page __ of __

Job:		**Station ID:**	
Job No:		**Attempt No.**	
Field Staff:		**Date:**	
Contractor:		**Logged By:**	
Vertical Datum:		**Horizontal Datum:**	

Field Collection Coordinates:

Lat/Northing: ______ Long/Easting: ______

A. Water Depth

DTM Depth Sounder: ______

DTM Lead Line: ______

B. Water Level Measurements

Time: ______

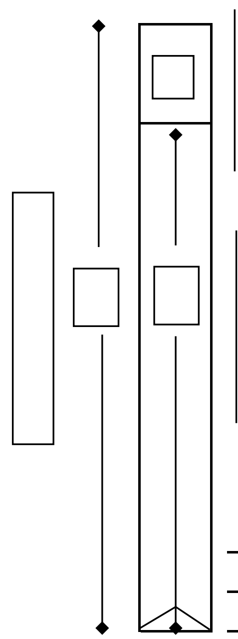
Tide Height: ______

Source: ______

C. Mudline Elevation

______

Recovery Measurements (prior to cuts)



Core Collection Recovery Details:

Core Accepted: Yes / No

Core Tube Length: ______

Drive Penetration: ______

Headspace Measurement: ______

Recovery Measurement: ______

Recovery Percentage: ______

Total Length of Core To Process: ______

Drive Notes:

Sections To Process:

A: ______

B: ______

C: ______

D: ______

Core Field Observations and Description:	Sediment type, moisture, color, minor modifier, MAJOR modifier, other constituents, odor, sheen, layering, anoxic layer, debris, plant matter, shells, biota

Notes:

Sediment Core Processing Log

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Job:	Station ID:
Job No.	Date/Time:
No. of Sections:	Core Logged By:
Drive Length:	Attempt #:
Recovery:	Type of Core ☐ Mudmole ☐ Vibracore ☐ Diver Core
% Recovery:	Diameter of Core (inches)
Notes:	Core Quality ☐ Good ☐ Fair ☐ Poor ☐ Disturbed

Recovered Length (ft)	Size % Gravel	Size % Sand	Size % Fines	**Classification and Remarks** (Density, Moisture, Color, Minor Constituent, MAJOR Constituent, with Additional Constituents, Sheen, Odor)	Recovered Length (ft)	PID	Sample	Summary Sketch

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Project:

Project Number:

Staff:

Sampling Method: Sheen Net (matrix code "SN")

Date:

Sampling Start Time:

Sampling End Time:

Sheet of

Surface Water Sheen Sample Collection and Observation Form

SAMPLE DETAILS					SHEEN DESCRIPTION					
Sample ID (Station ID for observations only)	**Sample Location**		**Sample or Observation Time**	**Water Depth**	**Sheen Type** (sheen type codes below)	**Sheen Color** (sheen color codes below)	**Sheen Structure** (sheen structures below)	**Sheen Dimensions** (feet)	**Sheen Blossoms per Minute** (if applicable)	**Additional Comments** (i.e., potential sheen source, if obvious)
	Northing	**Easting**								
Notes:										

Sheen Type:
[B] - Blossom; [SS] - Small Spots; [Sp] - Spotty; [St] - Streaks; [C] - Contiguous

Sheen Color:
[S] - Silvery; [R] - Rainbow; [DR] - Dark Rainbow; [D] - Dark

Sheen Structure:
Brittle; Non-Brittle

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Surface Sediment Field Log

Job: Station:

Job No: Date:

Field Staff: Sample Method:

Contractor: Proposed Coordinates: Lat.

Horizontal Datum: Long.

Water Height

DTM Depth Sounder: ________

DTM Lead Line: ________

Tide Measurements

Time: ________

Height: ________

Sample Acceptability Criteria:

1) Overlying water is present
2) Water has low turbidity
3) Sampler is not overfilled
4) Surface is flat
5) Desired penetration depth

Mudline Elevation (lower low water-large tides): calculated after sampling

Notes: ________

Grab #	Time	Confirmed Coordinates (datum)		Sample Accept (Y/N)	Recovery Depth (in)	Comments: jaws close, good seal, winnowing, overlying water, surface intact, etc
		WGS 84 (N)	WGS 84 (E)			

Sample Description: surface cover, (density), moisture, color, minor modifier, MAJOR modifier, other constituents, odor, sheen, layering, anoxic layer, debris, plant matter, shells, biota

Sample Containers:

Analyses:

Appendix B
Pre-Remedial Design Data Gaps
Quality Assurance Project Plan

ECSI No. 84
September 11, 2019
Gasco Sediments Cleanup Action

Pre-Remedial Design Data Gaps Quality Assurance Project Plan

Prepared for U.S. Environmental Protection Agency, Region 10

ECSI No. 84
September 11, 2019
Gasco Sediments Cleanup Action

Pre-Remedial Design Data Gaps Quality Assurance Project Plan

Prepared for
U.S. Environmental Protection Agency
Region 10
1200 Sixth Avenue
Seattle, Washington 98101

Prepared by
Anchor QEA, LLC
6720 SW Macadam Avenue
Suite 125
Portland, Oregon 97219

On Behalf of
NW Natural
220 NW 2nd Avenue
Portland, Oregon 97209

Project Number: 000029-02.59
\\fuji\anchor\Projects\NW Natural\Gasco\Sediments\Sediments New Action\New Early Action Eval\Pre-design Evaluations\Data Gaps Sampling\Pre-RD Data Gaps Work Plan\3_Appendices\App B_QAPP\Appendix B_Pre-RD DG QAPP.docx

APPROVAL PAGE

U.S. Environmental Protection Agency, Region 10

Sean Sheldrake, Project Manager

Signature: ______________________________ Date: ______________

U.S. Environmental Protection Agency, Region 10

Don Matheny, Quality Assurance Manager Designee

Signature: ______________________________ Date: ______________

NW Natural

Robert J. Wyatt, Director, Legacy Environmental Programs

Signature: ______________________________ Date: September 11, 2019

Anchor QEA, LLC

Ryan Barth, Project Manager

Signature: ______________________________ Date: September 11, 2019

Anchor QEA, LLC

Delaney Peterson, Project Quality Assurance Manager

Signature: ______________________________ Date: September 11, 2019

DISTRIBUTION LIST

The following individuals will receive copies of this document and any approved revisions:

Recipient	Title/Role	Organization
Sean Sheldrake	Project Manager	U.S. Environmental Protection Agency
Don Matheny	Quality Assurance Manager	U.S. Environmental Protection Agency
Robert J. Wyatt	Director, Legacy Environmental Programs	NW Natural
Ryan Barth	Partner-in-Charge/Project Manager	Anchor QEA, LLC
Nik Bacher	Field Coordinator	Anchor QEA, LLC
Laurel Menoche	Database Manager	Anchor QEA, LLC
Delaney Peterson	Project Quality Assurance Manager	Anchor QEA, LLC
Darwin Thomas	Laboratory Project Manager	Apex Laboratories
Liz Porta	Laboratory Project Manager	Alpha Analytical, Inc.
Martha Maier	Laboratory Project Manager	Vista Analytical Laboratory, Inc.
Amanda Volgardsen	Laboratory Project Manager	Analytical Resources, Inc.
Joe Tomei	Laboratory Project Manager	Geotesting Express
Larry Kunkel	Laboratory Project Manager	Core Laboratories
James B. Hyzy	Laboratory Project Manager	Waste Stream Technology, Inc.
Dobroslav Znidarcic	Laboratory Project Manager	University of Colorado
Christina Rink	Data Validator	Laboratory Data Consultants, Inc.

The Anchor QEA Project Quality Assurance Manager is responsible for maintaining the official, approved *Pre-Remedial Design Data Gaps Quality Assurance Project Plan*.

TABLE OF CONTENTS

TABLES

FIGURE

ATTACHMENT

ABBREVIATIONS

ASTM	ASTM International
CCV	continuing calibration verification
COC	chain of custody
DQO	data quality objective
EDL	estimated detection limit
EPA	U.S. Environmental Protection Agency
FC	Field Coordinator
FSP	*Pre-Remedial Design Data Gaps Field Sampling Plan*
HAZWOPER	Hazardous Waste Operations and Emergency Response
MD	matrix duplicate
MDL	method detection limit
MS	matrix spike
MSD	matrix spike duplicate
NAPL	nonaqueous phase liquid
NIST	National Institute of Standards and Technology
OPR	ongoing precision and recovery sample
OSHA	Occupational Safety and Health Administration
PDI	Pre-Design Investigation
QA	quality assurance
QAPP	*Pre-Remedial Design Data Gaps Quality Assurance Project Plan*
QC	quality control
RL	reporting limit
RPD	relative percent difference
SOP	standard operating procedure
Work Plan	*Pre-Remedial Design Data Gaps Work Plan*

1 Introduction

This *Pre-Remedial Design Data Gaps Quality Assurance Project Plan* (QAPP) has been prepared as Appendix B to the *Revised Pre-Remedial Design Data Gaps Work Plan* (Work Plan; Anchor QEA 2019a), which has been prepared under the *Administrative Settlement Agreement and Order on Consent* (Docket No. CERCLA 10-2009-0255) and *Statement of Work – Gasco Sediments Site* (EPA 2009a), as well as the Schedule of Deliverables approved by the U.S. Environmental Protection Agency (EPA) on June 19, 2017. The Work Plan summarizes the remaining data gaps identified in the *Final Pre-Remedial Basis of Design Technical Evaluations Work Plan* (TEWP; Anchor QEA 2019b) and the associated field sampling methodologies to fill those data gaps at the Gasco Sediments Site. The data gaps sampling is being implemented to collect additional site-specific data within the EPA-identified Gasco Project Area shown in Work Plan Figure 2 to refine the Gasco Sediments Site active cleanup boundaries identified in the *Draft Engineering Evaluation/Cost Estimate* (Anchor QEA 2012a) and subsequently refined in the *Record of Decision – Portland Harbor Superfund Site, Portland, Oregon* (ROD; EPA 2017a), as well as to support completion of the technical evaluations presented in the TEWP.

This QAPP establishes the quality assurance (QA) objectives for conducting sampling and evaluation activities described therein. The analytical methods and quality assurance procedures described here will be followed by NW Natural and its contractors during sample collection activities described in the Work Plan. See Table B-1a for a summary of programs, associated analyses, and rationale/objectives for each program. The goal of this QAPP is to ensure that data of sufficiently high quality are generated to support the project data quality objectives (DQOs). This QAPP will address project management responsibilities; sampling and analytical procedures; assessment and oversight; and data reduction, validation, and reporting.

This QAPP was prepared following U.S. Environmental Protection Agency's (EPA's) *Guidance for Quality Assurance Project Plans* (EPA 2002). Analytical QA/quality control (QC) procedures were also developed based on the analytical protocols and QA guidance of EPA's *Test Methods for the Evaluation of Solid Waste: Physical/Chemical Methods* (EPA 1986) and the EPA Contract Laboratory Program National Functional Guidelines for Data Review (EPA 2016, 2017b, 2017c).

1.1 Purpose and Objectives

The purpose of this program is to address the data gaps identified in the TEWP necessary to complete the final remedial design for the Gasco Sediments Site. The Work Plan presents the data gaps identified in the TEWP in two categories: those that do not and those that do require field sampling and analysis. See Work Plan Table 1 for each technical evaluation section in the TEWP that identifies a data gap, whether field sampling and analysis (versus the use of existing information) is required to fill the data gap, and the proposed sampling media for each data gap that requires field sampling and analysis.

1.2 Document Organization

EPA guidance (EPA 2002) specifies four groups of information that must be included in a QAPP (Project Management, Data Generation and Acquisition, Assessment and Oversight, and Data Validation and Usability). Each group comprises several QAPP elements. EPA's guidance provides a suggested outline for the QAPP elements. However, the guidance indicates that certain elements may not be applicable to a given project and that the elements need not be presented in the order presented in the guidance.

The remainder of this QAPP is organized into the following sections:

- Section 2 – Project Management
- Section 3 – Data Generation and Acquisition
- Section 4 – Assessment and Oversight
- Section 5 – Data Validation and Usability
- Section 6 – References

2 Project Management

This section identifies key project personnel, describes the rationale for conducting the investigation studies, identifies the studies to be performed and their respective schedules, outlines project DQOs and criteria, lists training and certification requirements for sampling personnel, and describes documentation and record keeping procedures.

2.1 Project Organization

Responsibilities of the team members, as well as Laboratory Project Managers, are described in the following sections. Contact information for each member of the project is provided in Table B-1b. The independent investigation being undertaken by NW Natural, as described in this QAPP and the associated *Pre-Remedial Design Data Gaps Field Sampling Plan* (FSP; Appendix A to the Work Plan), was developed with informal, but detailed, consultation with EPA. All material EPA comments and suggestions were considered by NW Natural and incorporated into this plan. A project organizational chart showing the relationships and lines of communication among project participants is presented in Figure B-1.

2.1.1 Project Planning and Coordination

The Project Manager, Ryan Barth of Anchor QEA, LLC, will act as the direct line of communication between contractors, NW Natural, and EPA, and he is responsible for implementing activities described in this QAPP. He will also be responsible for producing project deliverables and performing the administrative tasks needed to ensure the timely and successful completion of the investigation. The Project Manager will also be responsible for resolving project concerns or conflicts related to technical matters.

Mr. Barth will be responsible for preparation of the Pre-Design Investigation (PDI) Report. The PDI Report will summarize the sampling effort, analytical methods, QA/QC narrative, and analytical results.

2.1.2 Field Sample Collection

Nik Bacher of Anchor QEA, or his designee, will serve as the Field Coordinator (FC) and will provide direction to the field sampling in logistics, personnel assignments, and field operations. The FC will supervise the field collection of samples and will be responsible for ensuring accurate positioning and recording of sample locations, depths, and identification; conformity to sampling and handling requirements, including field decontamination procedures; physical evaluation and documentation of the samples; and delivery of the samples to the laboratories. He will ensure that the samples are stored under proper conditions while in custody until delivery to the laboratories. The FC will be responsible for summarizing field sampling activities, including details of the sampling effort, sample preparation, sample storage and transport procedures, field quality assurance, and documentation of any deviation from this QAPP.

The sampling will be completed by Anchor QEA and its subconsultants as described in the Work Plan. Subconsultants will follow the QA/QC and analytical protocols established in this QAPP.

2.1.3 Quality Assurance/Quality Control Management

Delaney Peterson of Anchor QEA, or her designee, will serve as the Project Quality Assurance Manager (Project QA Manager) for this project and will be responsible for the coordination with the analytical laboratories and field team. She will perform oversight for both the field sampling and laboratory programs. She will be kept fully informed of field program procedures and progress during sample collection and laboratory activities during sample preparation and analyses. She will record and correct any activities that vary from this QAPP. She will be responsible for the review of laboratory reports and case narratives describing any anomalies and exceptions that occurred during analysis. Any QA/QC problems will be brought to her attention as soon as possible to discuss issues related to the problem and evaluate potential solutions. She will be responsible for performing or overseeing the validation of the data according to the requirements of this QAPP and incorporating the results of the validation into the final project database. Upon completion of the sampling and analytical program, she will review laboratory QA/QC results and incorporate findings into the PDI Report.

The analytical laboratories will be responsible for physical and chemical analyses of sediment samples and will ensure that the submitted samples are handled and analyzed in accordance with the selected analytical testing protocols and QA/QC requirements, as well as the requirements specified in this QAPP. The laboratories will provide certified, pre-cleaned sample containers and sample preservatives, as appropriate, and prepare a data package containing the analytical and QA/QC results.

The Laboratory Project Managers for the physical and chemical testing are listed in Table B-1b. Each of them will oversee laboratory operations associated with the receipt of the environmental samples, chemical/physical analyses, and laboratory report preparation for this project. They will review the laboratory reports and prepare case narratives describing any anomalies and exceptions that occurred during sample preparation and analyses. They will also notify the Project QA Manager of any QA/QC problems when they are identified to allow for quick resolution.

2.2 Problem Definition/Background

The Work Plan describe the investigations that will be performed as part of the PDI at the NW Natural Gasco Site in Portland, Oregon. A detailed project overview, site description, project figures, and supporting field sampling details are provided in the Work Plan and Appendix A of the

Work Plan (the FSP). The data gaps sampling event is being implemented to collect additional site data in order to update the Gasco Sediments Site active cleanup boundaries (herein termed the Project Area) and to support the technical evaluations consistent with the Portland Harbor Superfund Site ROD (EPA 2017a) to develop a remedial design for the Project Area.

2.3 Project/Task Description and Schedule

Sampling activities described in the Work Plan and FSP will be initiated following EPA approval. The data gaps sampling activities are currently estimated to occur between September through November contingent on meeting the current EPA approval timeline for the Work Plan. See Work Plan and FSP Sections 3 for descriptions of the specific tasks to be conducted. Work Plan Figures 3, 4, 6, 8, 9, and 11 to 13 show sampling locations. The sampling schedule is discussed in FSP Section 6.

2.4 Data Quality Objectives and Criteria

The DQOs for this project are to develop and implement procedures that will ensure the collection of representative data of known, acceptable, and defensible quality to achieve the project objectives described in the Work Plan and FSP. The quality of the laboratory data is assessed by precision, accuracy, representativeness, comparability, completeness, bias, and sensitivity (see Section 3.4).

2.5 Special Training Requirements/Certifications

For sample preparation tasks, it is important that field personnel are trained in standardized data collection requirements so that the data collected are consistent among the field crew. Field personnel must be fully trained in the collection and processing of surface sediment grab samples and subsurface sediment core samples, collection of porewater samples, collection of sheen net samples, decontamination protocols, visual inspections, and chain-of-custody (COC) procedures. Training for staff will be provided through on-the-job training and attendance at internal and external seminars and workshops on relevant subject matter. The Anchor QEA FC will be responsible for ensuring that staff and any contractors have the necessary training required to conduct the field investigation procedures described in the Work Plan, FSP, and this QAPP.

In addition, the 29 Code of Federal Regulations 1910.120 Occupational Safety and Health Administration (OSHA) regulations require training to provide employees with the knowledge and skills enabling them to perform their jobs safely and with minimum risk to their personal health. Sampling personnel will have completed the 40-hour Hazardous Waste Operations and Emergency Response (HAZWOPER) training course and 8-hour refresher courses, as necessary, to meet OSHA regulations. Anchor QEA's project Health and Safety Officer, Chris Torell, is responsible for the completion and retention of HAZWOPER certification. In addition, all sampling personnel will have basic training in boat safety for the over-water work. Certifications will be maintained in Anchor QEA's project files.

2.6 Documentation and Records

This project will require central project files to be maintained at Anchor QEA for a minimum of 10 years. Project records will be stored and maintained in a secure manner. The Project QA Manager will be responsible for maintaining and providing updated copies of the most current approved version of the QAPP. Updates will be distributed to appropriate personnel electronically. Each project team member is responsible for filing necessary project information or providing it to the person responsible for the filing system. Individual team members may maintain files for individual tasks but must provide such files to the central project files upon completion of each task. Hard copy documents will be kept on file at Anchor QEA or at a document storage facility throughout the duration of the project, and electronic data will be maintained in the Anchor QEA central database and backed up regularly as part of routine file maintenance.

2.6.1 Field Records

Documents generated during the field effort are controlled documents that become part of the project file. Field documents may be generated electronically or recorded on hard copies in the field. Field team members will keep a daily record of significant events, observations, and measurements on field logs developed specifically for each activity. The field logs will be the main source of documentation for field activities and will be maintained by the FC. The sampling documentation will contain information on each sample collected and will include, at a minimum, the following information:

- Project name
- Field personnel on site
- Facility visitors
- Weather conditions
- Field observations
- Maps and/or drawings
- Sample collection date and time
- Sampling method and description of activities
- Identification or serial numbers of instruments or equipment used
- Deviations from the Work Plan, FSP, or QAPP
- Conferences associated with field sampling activities

Entries for each day will begin on a new form. The person recording information must enter the date and time and initial each entry. Additional specific field reporting requirements and checklists for each study are defined in the Work Plan and FSP. In general, sufficient information will be recorded during each sampling event so that reconstruction of the event can occur without relying on the memory of the field personnel.

The field forms will be either collected electronically or on water-resistant, durable paper to prevent deterioration of the project record due to adverse field conditions. Hard copy notes will be taken in indelible, waterproof blue or black ink. Errors will be corrected by drawing a single line through the error, writing in the correct information, then dating and initialing the change. Each form will be marked with the project name, number, and date. The field forms will be scanned into Anchor QEA's project file directory as convenient during the sampling event or upon completion of each sampling event.

Sample collection tables are included in the FSP and will be used to inform proposed coordinates of each location, the sampling scheme, and whether any QC samples are to be collected.

2.6.2 Analytical and Chemistry Records

The laboratory will retain analytical data records. Additionally, Anchor QEA will retain them in central project files. For chemical analyses, the data reporting requirements will include those items necessary to complete data validation, including copies of raw data. The laboratories will prepare a detailed laboratory data package documenting the activities associated with the sample analyses. Laboratory data packages will contain information necessary to perform a Stage 4 data validation per EPA guidelines (EPA 2009b), and one Stage 4 validation will be conducted on one representative data package submitted from each laboratory, with the exceptions of geotechnical and nonaqueous phase liquid (NAPL) mobility data. Stage 2B validations will be conducted on the remainder of the data, with the exceptions of the geotechnical and NAPL mobility data, unless the Stage 4 validations reveal errors or issues that warrant additional Stage 4 validations. Stage 1 validations will be conducted on geotechnical and NAPL mobility data. The laboratory data reports will include, but are not limited to, the following information:

- **Project Narrative.** This summary, in the form of a cover letter, will discuss problems (if any) encountered during any aspect of sample receipt, preparation, and analyses. This summary will discuss, but not be limited to, sample receipt, sample storage, QC deviations, and any other analytical difficulties. Problems encountered, actual or perceived, and their resolutions will be documented in as much detail as appropriate.
- **COC Records.** Legible copies of the COC forms will be provided as part of the data package. This documentation will include the time of receipt and condition of the samples received by the laboratory. Additional internal tracking of sample custody by the laboratory will also be documented on a sample receipt form. The form must include sample shipping container temperatures measured at the time of sample receipt.

- **Sample Results.** The data package will summarize the results for each sample analyzed. The summary will include the following information when applicable:
  - Field sample identification code and the corresponding laboratory identification code
  - Sample matrix
  - Date of sample preparation
  - Date and time of analysis
  - Weight and/or volume used for analysis
  - Final dilution or concentration factor for the sample
  - Identification of the instrument used for analysis
  - Method detection and reporting limits accounting for sample-specific factors (e.g., dilution and total solids)
  - Analytical results with reporting units identified
  - Data qualifiers and their definitions
- **QA/QC Summaries.** This section contains the results of the laboratory QA/QC procedures. Each QA/QC sample analysis will be documented with the same information required for the sample results. No recovery or blank corrections will be made by the laboratory. The required summaries include, but are not limited to, the following:
  - **Calibration Data Summary.** This summary will report the concentrations of the initial calibration and daily calibration standards and the date and time of analysis. The response factor, percent relative standard deviation, percent difference, and retention time for each analyte will be listed, as appropriate. Results for standards used to quantify instrument sensitivity will be documented.
  - **Instrument Performance Checks.** Ion abundances and the ranges of acceptable criteria will be reported for gas chromatography/mass spectrometry methods. Mass calibration atomic mass unit and percent relative standard deviation values will be reported for inductively coupled plasma/mass spectrometry methods.
  - **Internal Standard Area Summary.** Internal standard areas will be reported for each sample analyzed, as appropriate.
  - **Method Blank Analysis.** The method blank analyses associated with each sample and the concentration of compounds of interest identified in these blanks will be reported.
  - **Surrogate Spike Recovery.** Surrogate spike recovery results for organic analyses will be reported for each sample. The names and concentrations of the compounds added, percent recoveries, and range of acceptable recoveries will be reported.
  - **Matrix Spike Recovery.** The names and concentrations of analytes added, percent recoveries, and range of acceptable recoveries will be listed. The relative percent difference (RPD) for matrix spike duplicate (MSD) analyses will be reported.
  - **Matrix Duplicate.** This summary will include the RPD or difference value for matrix duplicate (MD) analyses, as appropriate to the sample concentrations.

- **Laboratory Control Sample.** The name and concentration of analytes added, percent recoveries, and range of acceptable recoveries will be listed. The RPD values for laboratory control sample duplicate analyses will be included.
- **Relative Retention Time.** This summary will include a report of the relative retention time of each analyte detected in the samples for both primary and confirmatory analyses.

- **Original Data.** Legible copies of the original data generated by the laboratory will include the following:
  - Identification of preparation method used and cleanup logs, as appropriate
  - Instrument specifications and analysis logs for instruments used on days of calibration and analysis
  - Original printouts of full-scan chromatograms and quantitation reports for gas chromatography and/or gas chromatography/mass spectrometry samples, blanks, calibrations, spikes, replicates, and reference materials
  - Reconstructed ion chromatograms for samples, standards, blanks, spikes, replicates, and reference materials
  - Enhanced spectra of detected compounds with associated best-match spectra for each sample
  - Instrument outputs for inorganic analyses, including calibrations and sample analyses
  - Calculation worksheets

Instrument data shall be fully restorable at the laboratory from electronic backup. The laboratory will be required to maintain records relevant to project analyses for a minimum of 5 years. Data validation reports will be maintained in the central project files with the analytical data reports.

2.6.3 Data Reduction

Data reduction is the process by which original data (analytical measurements) are converted or reduced to a specified format or unit to facilitate analysis of the data. Data reduction requires that aspects of sample preparation that could affect the test result (such as sample volume analyzed or dilutions required) be taken into account in the final result. Data reduction is the laboratory analyst's responsibility, and final results are subjected to further review by the Laboratory Project Manager, the Project Manager, the Project QA Manager, and independent reviewers. Data reduction may be performed manually or electronically. If performed electronically, software used must be demonstrated to be true and free from error.

3 Data Generation and Acquisition

Data generation and acquisition begins with the development of the rationale for locating and selecting environmental samples for analysis and ends with the generation and reporting of analytical data for those samples by the analytical laboratories.

3.1 Sampling Design

The sampling design including the rationale for locating and selecting environmental samples for analyses is detailed in the FSP.

3.2 Sampling Methods and Handling Requirements

Sample collection procedures are described in detail in the FSP. Sampling procedures are generally consistent with EPA protocols or other approved sample collection standards established for the site.

3.3 Analytical Methods

Analytical methods for chemical and physical analyses are listed in Tables B-2a through B-7, corresponding to the sample and analytical programs described in FSP Section 5.

In completing analyses for this project, the laboratories are expected to meet the following minimum requirements:

- Adhere to the methods outlined in this QAPP, including methods referenced for each analytical procedure.
- Follow documentation, custody, and sample tracking procedures.
- Notify the Project QA Manager of any QA/QC problems when they are identified.
- Provide a detailed discussion of any modifications made to approved analytical methods.
- Deliver Adobe PDF and electronic data as specified.
- Meet reporting requirements for deliverables.
- Meet turnaround times for deliverables.
- Implement QA/QC procedures, including the DQOs, laboratory QA requirements, and performance evaluation testing requirements.
- Allow laboratory and data audits to be performed, if deemed necessary.

Analytical methods and reporting limits (RLs) for sediment, aqueous, elutriate, and sheen net samples are presented in Tables B-2a through B-7. Table B-8 presents the field and laboratory QA/QC sample frequency requirements (e.g., field duplicates, matrix spikes (MSs), and laboratory control samples).

3.4 Data Quality Objectives

The parameters used to assess data quality are precision, accuracy, representativeness, comparability, completeness, bias, and sensitivity. These parameters are presented on Table B-9 and discussed in greater detail in the following sections.

3.4.1 Precision

Precision is the ability of an analytical method or instrument to reproduce its own measurement. It is a measure of the variability or random error in sample collection and laboratory analyses.
ASTM International (ASTM) recognizes the following two levels of precision (ASTM 2002):

1. Repeatability: the random error associated with measurements made by a single test operator on identical aliquots of test material in a given laboratory, with the same apparatus, under constant operating conditions
2. Reproducibility: the random error associated with measurements made by different test operators in different laboratories, using the same method but different equipment to analyze identical samples of test material

In the laboratory, "within-batch" precision is measured using replicate sample or QC analyses and is expressed as the RPD between the measurements. The "batch-to-batch" precision is determined from the variance observed in the analysis of standard solutions or laboratory control samples from multiple analytical batches.

Field precision will be evaluated by the collection of field duplicates analyses at a frequency of 1 per 20 samples collected. Field chemistry duplicate precision will be screened against an RPD of 50% for all analyses and matrices. Data qualification based on field duplicate precision will be at the discretion of the data validator. The equation used to express precision is as follows:

Equation 1

$$\mathrm{RPD} = \frac{(\mathrm{C}_1 - \mathrm{C}_2) \times 100\%}{(\mathrm{C}_1 + \mathrm{C}_2)/2}$$

where:

RPD	=	relative percent difference
C_1	=	larger of the two observed values
C_2	=	smaller of the two observed values

Precision measurements can be affected by the nearness of a chemical concentration to the RL, where the percent error (expressed as RPD) increases. In cases where either the parent or duplicate result is less than five times the RL, results will be evaluated by the difference with a control limit of ± RL for aqueous sample matrices and ± 2 times the RL for solid sample matrices.

3.4.2 Accuracy

Accuracy is a measure of the closeness of an individual measurement (or an average of multiple measurements) to the true or expected value. Accuracy is evaluated by calculating percent recovery results from analyses of laboratory control samples, standard reference materials, surrogate standards, and standard solutions. In addition, matrix-spiked samples, laboratory control samples (e.g., blank spikes and reference materials), and surrogate spikes are also analyzed, which provide accuracy or bias information in the actual sample matrix. Accuracy measurements will be carried out at a minimum frequency of 1 per 20 samples analyzed, with the exception of surrogates, which will be added to all samples. Accuracy is expressed as percent recovery of the measured value, relative to the true or expected value. If a measurement process produces results for which the result is not the true or expected value, the process is said to be biased. Bias is discussed further in Section 3.4.6.

Laboratory accuracy will be evaluated against quantitative spike recovery performance criteria provided by the laboratory and shown in Table B-9. Accuracy can be expressed as a percentage of the true or reference value or as a percent recovery in those analyses where reference materials are not available and spiked samples are analyzed. The equation used to express accuracy is as follows:

Equation 2

$$\%R = 100\% \times (S\text{-}U)/C_{sa}$$

where:

%R	=	percent recovery
S	=	measured concentration in the spiked aliquot
U	=	measured concentration in the unspiked aliquot
C_{sa}	=	actual concentration of spike added

MS recovery values become distorted when the sample concentration is greater than four times the spike concentration. No data will be qualified in these instances, regardless of percent recovery values.

Field accuracy will be controlled by adherence to sample collection procedures outlined in the Work Plan and the FSP.

3.4.3 Representativeness

Representativeness expresses the degree to which data accurately and precisely represent an environmental condition. For the site, the list of analytes has been identified to provide a comprehensive assessment of the known and potential contaminants.

3.4.4 Comparability

Comparability expresses the confidence with which one dataset can be evaluated in relation to another dataset. For this program, comparability of data will be established through the use of standard analytical methodologies and reporting formats and common traceable calibration and spike materials.

3.4.5 Completeness

Completeness is a measure of the amount of data that is determined to be valid in proportion to the amount of data collected. Completeness will be calculated as follows:

Equation 3

$$C = \frac{\text{(Number of acceptable data points) x 100}}{\text{(Total number of data points)}}$$

where:

C = Completeness (%)

The DQO for completeness for components of this project is 95%. Data that have been qualified as estimated because QC criteria were not met will be considered valid for the purpose of assessing completeness. Data that have been rejected will not be considered valid for the purpose of assessing completeness.

3.4.6 Bias

Bias is the systematic or persistent distortion of a measurement process that causes errors in one direction. Bias can be either inherent in a method of analysis (e.g., extraction efficiency) or caused by an artifact of the measurement system (e.g., contamination). Bias assessments for environmental measurements are made using personnel, equipment, and spiking materials or reference materials as independent as possible from those used in the calibration of the measurement system. Analytical laboratories utilize several quality control measures to eliminate analytical bias, including systematic analyses of method blanks, laboratory control samples, and independent calibration verification standards. When possible, bias assessments should be based on analysis of spiked samples or matrix-matched reference samples rather than spiked blanks so that the effect of the matrix on recovery is incorporated into the assessment. A documented spiking protocol and consistency in following that protocol are important to obtaining meaningful data quality estimates. Because bias can be positive or negative and because several types of bias can occur simultaneously, only the net or total bias can be evaluated in a measurement.

3.4.7 Sensitivity

Analytical sensitivities must be consistent with or lower than the target limits listed in Tables B-2a through B-7 in order to demonstrate compliance with this QAPP.

The method detection limit (MDL) is defined as the minimum concentration at which a given target analyte can be measured and reported with 99% confidence that the analyte concentration is greater than zero. The limit of detection is the smallest amount or concentration of a substance that must be present in a sample in order to be detected at a 99% confidence level. Estimated detection limits (EDLs) are associated with high-resolution analytical methods and are calculated for each analyte and sample based on the signal-to-noise ratio. Undetected compounds analyzed by high-resolution methodology (e.g., dioxin/furans) will be reported at the EDL, which is typically lower than the MDL listed in Table B-2 and is sample and compound specific. The EDL is anticipated to meet ROD cleanup levels in most cases. Detections between the EDL and RL will be reported as estimated. Laboratory practical quantitation limits, limits of quantitation, or RLs are defined as the lowest level that produces a quantitative result within specified limits of precision and accuracy during routine laboratory operating conditions. Laboratory MDL and RL results (Tables B-2a through B-7) will be used to evaluate the method sensitivity and/or applicability prior to the acceptance of a method for this program.

The sample-specific MDLs, EDLs, and RLs will be reported by the laboratory and will take into account factors relating to the sample analysis that might decrease or increase the MDLs and RLs (e.g., dilution factor, percent moisture, and sample aliquot weight or volume). In the event that the MDL (or EDL) and RL are elevated for a sample due to matrix interferences and subsequent dilution or reduction in the sample aliquot, the data will be evaluated by Anchor QEA and the laboratory to determine if an alternative course of action is required or possible. The sample-specific MDL and RL will be the value recorded in the project database.

Estimated detection limits are dependent on sample and analysis-specific factors. They are calculated at the time of analysis and are typically only reported when analytes are below detection. Since they are not pre-determined, NW Natural cannot include them in the QAPP tables; however, NW Natural does anticipate they will be below MDLs and the ROD Table 17 CULs for samples without significant matrix interferences based on other project experience.

3.5 Quality Assurance and Quality Control

Field and laboratory activities must be conducted in such a manner that the results meet specified quality objectives and are fully defensible. Guidance for QA/QC is derived from the protocols developed for EPA's *Test Methods for the Evaluation of Solid Waste: Physical/Chemical Methods* (EPA 1986), the EPA Contract Laboratory Program (EPA 2016, 2017b, 2017c), and the cited methods.

3.5.1 Field Quality Control

Anchor QEA personnel will identify and label samples in a consistent manner to ensure that field samples are traceable, and labels provide the information necessary for the laboratory to properly conduct the required analyses. Samples will be placed in appropriate containers and preserved for shipment to the laboratory.

3.5.1.1 Sample Containers

The analytical laboratories will provide certified pre-cleaned sample containers (Tables B-10 through B-12) with the exceptions of the geotechnical analyses. The laboratories will maintain documentation certifying the cleanliness of bottles and the purity of preservatives provided.

Geotechnical samples will be collected in clean sample containers for disturbed samples and in thin-walled steel samplers (ASTM D1587) for undisturbed samples.

3.5.1.2 Sample Identification and Labels

Each sample will have an adhesive plastic or waterproof paper label affixed to the container and will be labeled at the time of collection. The following information will be recorded on the container label:

- Project name
- Sample identification
- Date and time of sample collection
- Preservative type (if applicable)
- Required analyses
- Sampler's name or initials

Samples will be uniquely identified with a sample identification that, at a minimum, specifies sample matrix, sample number, sample location, and type of sample. Specific sample nomenclature is described in the FSP.

3.5.1.3 Sample Custody and Shipping Requirements

Samples are considered to be in one's custody if they are in the following: 1) the custodian's possession or view; 2) a secured location (under lock) with restricted access; or 3) a container that is secured with official seals such that the sample cannot be reached without breaking the seals.

COC procedures will be followed for the samples throughout the collection, handling, and analysis process. The principal document used to track possession and transfer of samples is the COC form. Each sample will be represented on a COC form the day it is collected. Data entries will be made using indelible ink pen. Corrections will be made by drawing a single line through the error, writing in the correct information, then dating and initialing the change. Blank lines or spaces on the COC form will be lined out, dated, and initialed by the individual maintaining custody.

A COC form will accompany each cooler of samples sent to the analytical laboratories. Each person who has custody of the samples will sign the COC form and establish that the samples were not left unattended unless properly secured. Copies of COC forms will be retained in the project files.

Filled sample containers for chemistry and physical analyses will be stored in coolers containing ice to maintain the samples at 2°C to 6°C until delivery to the analytical laboratories.

Samples will be shipped to the analytical laboratory no later than the day after collection. Samples collected on Friday may be held until the following Monday for shipment provided that this does not jeopardize any hold time requirements (Tables B-10 through B-12). Specific sample shipping procedures are as follows:

- Each cooler or container with the samples for analysis will be hand-delivered, couriered, or shipped the same day as collection or via overnight delivery to the appropriate analytical laboratory. In the event that Saturday delivery is required, the FC will contact the analytical laboratory before 3:00 p.m. on Friday to ensure that the laboratory will be staffed to receive samples on a Saturday and is aware of the number of containers shipped and the airbill tracking numbers for those containers. Following shipment, the FC will confirm the samples have been received and are in good condition.
- Coolant ice will be sealed in separate zip-top plastic bags and placed in the shipping containers. Plastic bags will be doubled for overnight shipping.
- Individual sample containers will be placed in a sealable plastic bag, packed to prevent breakage, and transported in a sealed ice chest or other suitable container.
- Glass bottles and jars will be separated in the shipping container by shock-absorbent material (e.g., bubble wrap) to prevent breakage.
- The shipping containers will be clearly labeled with sufficient information (name of project, time and date container was sealed, person sealing the container, and consultant's office name and address) to enable positive identification.
- COC forms will be enclosed in a plastic bag and placed inside of the cooler.
- A minimum of two signed and dated COC seals will be placed on adjacent sides of each cooler prior to shipping.
- Each cooler will be wrapped securely with packing tape and will be clearly labeled with the laboratory's shipping address and the consultant's return address.

Upon transfer of sample possession to the analytical laboratory, the person transferring custody of the sample container will sign the COC form. Upon receipt of samples at the laboratory, the shipping container seals will be broken, and the receiver will sign the COC forms and record the condition of the samples and any discrepancies encountered on a sample receipt form.

3.5.1.4 Field Quality Assurance Sampling

Field QA procedures will consist of following procedures for acceptable practices for collecting and handling of samples. Adherence to these procedures will be complemented by periodic and routine equipment inspection.

Field QA samples will be collected along with the environmental samples. Field QA samples are useful in identifying possible problems resulting from sample collection or sample processing in the field. The collection of field QA samples includes equipment rinsate blanks and field duplicates as specified in Table B-8. Rinsate blanks will be collected at a frequency of one per collection method per sampling event. If decontamination procedures are not adequate, additional rinsate blanks will be collected after procedures have been modified. Adequacy of decontamination procedures will be evaluated by rinsate blank chemistry results. Results will be compared to associated samples, and the Project QA Manager's best professional judgment will be used to evaluate whether decontamination procedures should be modified. Field duplicate samples will be collected at a frequency of one per sampling event or 1 in 20 samples collected, whichever is more frequent.

Field QA samples will also include the collection of additional sample volume or mass to ensure that the laboratory has sufficient sample volume to run the program-required analytical QA/QC (MD/MS/MSD) samples for analysis as specified in Table B-8. Additional sample volume or mass to meet this requirement will be collected at a frequency of one per sampling event or 1 in 20 samples processed, whichever is more frequent. The sample collection team will confirm with the laboratory the appropriate extra volume or mass required for these analyses. The samples designated for MD/MS/MSD analyses should be clearly marked on the COC.

Field QA samples will be documented on the field forms and verified by the Project QA Manager or designee.

3.5.2 Laboratory Quality Control

Laboratory QC procedures, where applicable, include initial and continuing instrument calibrations, standard reference materials, laboratory control samples, matrix replicates, MSs, surrogate spikes (for organic analyses), and method blanks. Table B-8 lists the frequency of analysis for laboratory QA/QC samples, and Table B-9 summarizes the DQOs for precision, accuracy, and completeness.

An analyst will review the results of the QC samples from each analytical batch immediately after a sample group has been analyzed. The QC sample results will then be evaluated to determine if control limits have been exceeded. If control limits are exceeded in the batch and reanalysis or re-extraction does not correct the exceedance, the Project QA Manager will be contacted and alternative corrective action (e.g., method modifications followed by reprocessing the affected samples) will be explored prior to processing a subsequent group of samples.

3.5.2.1 Laboratory Instrument Calibration and Frequency

An initial calibration will be performed on each laboratory instrument to be used prior to analyses, after each major interruption to the analytical instrument, and when any ongoing calibration does not meet method control criteria. A calibration verification sample will be analyzed following each initial calibration and will meet method criteria prior to analysis of samples. Continuing calibration verifications (CCVs) will be analyzed at required frequencies to track instrument performance. The frequency of CCVs varies with method. For gas chromatography/mass spectrometry methods, one will be analyzed every 12 hours. For gas chromatography, metals, and inorganic methods, 1 will be analyzed for every 10 field samples analyzed and at the end of each run. If the CCV is out of control, the analysis must come to a halt until the source of the control failure is eliminated or reduced enough to meet control specifications. Project samples analyzed while instrument calibration was out of control will be reanalyzed.

Instrument blanks or continuing calibration blanks provide information on the stability of the baseline established. Continuing calibration blanks will be analyzed immediately prior to or right after the CCV as applicable to the method.

3.5.2.2 Laboratory Duplicates

Laboratory duplicates provide information on the precision of the analysis and are useful in assessing potential sample heterogeneity and matrix effects. Laboratory duplicates are subsamples of the original sample that are prepared and analyzed as a separate sample. For high-resolution mass spectrometry analyses, laboratory duplicates will be analyzed to assess laboratory precision. An MSD, ongoing precision and recovery sample (OPR) duplicate, or lab control sample duplicate may be analyzed in lieu of a laboratory duplicate.

3.5.2.3 Matrix Spikes and Matrix Spike Duplicates

Analyses of MS samples provide information on the extraction efficiency of the method on the sample matrix, as well as any interferences introduced by the sample matrix. By performing duplicate MS analyses, information on the precision of the method is also provided.

3.5.2.4 Method Blanks

Method blanks are analyzed to assess possible laboratory contamination at every stage of sample preparation and analysis. The method blank results must be less than the reporting limit of each target analyte. If a laboratory method blank exceeds this criterion for any analyte, and the analyte is detected in any of the samples and is less than five times the concentration found in the blank (10 times for common contaminants), analyses must stop, and the source of contamination must be eliminated or reduced.

3.5.2.5 Laboratory Control and Ongoing Precision and Recovery Samples

Laboratory control samples and OPRs are analyzed to assess possible laboratory bias at the stages of sample preparation and analysis. The laboratory control sample is a matrix-dependent spiked sample prepared at the time of sample extraction along with the preparation of the sample, method blank, and MS. The laboratory control sample and OPR will provide information on the accuracy of the analytical process and, when analyzed in duplicate, will provide precision information as well.

3.5.2.6 Laboratory Deliverables

Data packages will be checked for completeness immediately upon receipt from the laboratory to ensure that data and QA/QC information requested in Section 2.6.2 are present.

3.6 Instrument/Equipment Testing, Inspection, and Maintenance Requirements

Testing, inspection, and maintenance of field and laboratory equipment are important determinants of the quality of sampling and analysis results.

3.6.1 Field Instruments/Equipment

In accordance with the QA program, Anchor QEA shall maintain an inventory of field instruments and equipment. The frequency and types of maintenance will be based on the manufacturer's recommendations and/or previous experience with the equipment.

The Anchor QEA FC will be responsible for the preparation, documentation, and implementation of the preventative maintenance program. The equipment maintenance information will be documented in the instrument's calibration log. The frequency of maintenance is dependent on the type and stability of the equipment, the methods used, the intended use of the equipment, and the recommendations of the manufacturer. Detailed information regarding the maintenance procedures and frequency of equipment maintenance is provided in specific manufacturer's instruction manuals.

Maintenance records will be verified prior to each sampling event. The FC will be responsible for verifying that required maintenance has been performed prior to using the equipment in the field.

The worker or subcontractor responsible for navigation will confirm proper operation of the navigation equipment daily. This verification may consist of internal diagnostics or visiting a location with known coordinates to confirm the coordinates indicated by the navigation system. The winch line and grab sampler will be inspected daily for fraying, jaw misalignment, loose connections, and any other applicable mechanical problems. All equipment will be operated and maintained according to manufacturer specifications. Any problems will be noted in the field logbook and corrected prior to continuing sampling operations.

3.6.2 Laboratory Instruments/Equipment

In accordance with the QA program, the laboratory shall maintain an inventory of instruments and equipment, and the frequency of maintenance will be based on the manufacturer's recommendations and previous experience with the equipment.

The laboratory preventative maintenance program, as detailed in the laboratory QA Manual, is organized to maintain proper instrument and equipment performance and to prevent instrument and equipment failure during use. The program considers instrumentation, equipment, and parts that are subject to wear, deterioration, or other changes in operational characteristics; the availability of spare parts; and the frequency at which maintenance is required. Any equipment that has been overloaded or mishandled, gives suspect results, or has been determined to be defective will be taken out of service, tagged with the discrepancy noted, and stored in a designated area until the equipment has been repaired. After repair, the equipment will be tested to ensure that it is in proper operational condition. The client will be promptly notified in writing if defective equipment casts doubt on the validity of analytical data. The client will also be notified immediately regarding any delays due to instrument malfunctions that could impact holding times.

Laboratories will be responsible for the preparation, documentation, and implementation of the preventative maintenance program. Maintenance records will be checked according to the schedule on an annual basis and recorded by the responsible individual. The Laboratory Manager, or designee, shall be responsible for verifying compliance with the preventative maintenance program.

3.7 Instrument Calibration

Proper calibration of equipment and instrumentation is an integral part of the process that provides quality data. Instrumentation and equipment used to generate data must be calibrated at a frequency that ensures sufficient and consistent accuracy and reproducibility.

3.7.1 Field Instrument/Equipment Calibration

Field equipment will be calibrated prior to each sampling event according to manufacturer's recommendations and using manufacturer's calibration standards. The equipment, calibration, and maintenance information will be documented in the instrument calibration log. The frequency of calibration is dependent on the type and stability of the equipment, the methods used, the intended use of the equipment, and the recommendations of the manufacturer. Detailed information regarding the calibration and frequency of equipment calibration is provided in specific manufacturer's instruction manuals.

Equipment that fails calibration or becomes inoperable during use will be removed from service and tagged (time and date of action) to prevent inadvertent use. Such equipment will be satisfactorily recalibrated or repaired and tagged (date and time of return to service) prior to use.

A post-survey calibration check may be performed at the end of each day's activities to confirm that the instrument functioned properly throughout the day. The instrument will also be checked during the day if erratic or suspect readings are observed.

3.7.2 Laboratory Instrument/Equipment Calibration

As part of their QC program, laboratories perform two types of calibrations. A periodic calibration is performed at prescribed intervals (i.e., balances, drying ovens, refrigerators, and thermometers), and operational calibrations are performed daily, at a specified frequency, or prior to analysis (i.e., initial calibrations) according to method requirements. Calibration procedures and frequency are discussed in the laboratory QA Manual. Calibrations are discussed in the laboratory standard operating procedures (SOPs) for analyses.

The Laboratory Manager will be responsible for ensuring that the laboratory instrumentation is calibrated in accordance with specifications. Implementation of the calibration program shall be the responsibility of the respective laboratory department supervisors. Recognized procedures (EPA, ASTM, or manufacturer's instructions) shall be used when available.

Physical standards (i.e., weights or certified thermometers) shall be traceable to nationally recognized standards such as the National Institute of Standards and Technology (NIST). Chemical reference standards shall be NIST standard reference materials or vendor-certified materials traceable to these standards.

The calibration requirements for each method and respective corrective actions are written in the laboratory SOPs and/or the laboratory's QA Manual for each instrument or analytical method in use. Calibrations shall be preserved on electronic media.

3.8 Inspection/Acceptance Requirements for Supplies and Consumables

Inspection and acceptance of field supplies, including laboratory-prepared sampling bottles, will be the responsibility of the FC. Primary chemical standards and standard solutions will be used in this project in the field and laboratory and will be traceable to documented, reliable, commercial sources. Standards will be validated to determine their accuracy by comparison with an independent standard. Any impurities found in the standard will be documented.

3.9 Non-Direct Measurements

Non-direct measurements are suitable for use in the data gaps evaluation without limitation for the purposes of the data gaps evaluation stated in the Work Plan and FSP. Specifically, the criteria that will be used to evaluate the surface and subsurface sediment results will include the following:

- Existing data from the Portland Harbor Feasibility Study database, including surface sediment results from 0 to 30 cm (0 to 1 foot) below mudline and subsurface sediment results from samples greater than 30 cm (1 foot) below mudline
- Existing upland data (e.g., soil, groundwater) and riverbank data, if collected under oversight of EPA or the Oregon Department of Environmental Quality and in an area adjacent to the EPA-Identified Gasco Project Area
- Bathymetry and other survey data (e.g., debris survey) collected for the Portland Harbor Remedial Investigation/Feasibility Study and for the Gasco Sediments Site
- Bathymetry data collected by others within the EPA-Identified Gasco Project Area during the past 20 years
- Portland Harbor remedial action levels and cleanup goals included in the ROD

3.10 Data Management

Field data sheets will be checked for completeness and accuracy by the FC prior to delivery to the Project QA Manager. Data generated in the field will be documented electronically or on hard copy and loaded directly into the database or provided to the Project QA Manager, who will coordinate data entry into the database. Manually entered data will be checked by a second party. Field documentation will be filed in the main project file after data entry and checking are complete.

Laboratory data will be loaded directly into the database or provided to the Project QA Manager in the EQuIS electronic format. Laboratory data that is electronically provided and loaded into the database will undergo a check against the laboratory hard copy data. Data will be validated or reviewed manually, and qualifiers (if assigned) will be entered manually. The accuracy of manually entered data will be verified. Data tables and reports will be exported from EQuIS to Microsoft Excel tables. The *Pre-Remedial Design Data Gaps Data Management Plan* (Attachment A) outlines how the data will be handled from planning, field, and post-field work. The process for archiving and retrieving the data and the responsible individuals are also included in the *Pre-Remedial Design Data Gaps Data Management Plan.*

4 Assessment and Oversight

Once data are received from the laboratory, a number of QC procedures will be followed to provide an accurate evaluation of the data quality. Specific procedures will be followed to assess data precision, accuracy, and completeness.

4.1 Field and Laboratory Audits/Inspections

Laboratory and field performance audits or inspections consist of on-site reviews of QA systems and equipment for sampling, calibration, and measurement. Laboratory audits will not be conducted as part of this study. However, laboratory audit reports will be made available to the Project QA Manager upon request. Apex, ARI, Alpha, and Vista are NELAC-certified laboratories that undergo regular audits as part of their certification procedures. Audits are conducted no more than 2 years apart. The laboratory is required to have written procedures addressing internal QA/QC. These procedures have been submitted, and the Project QA Manager will review them to ensure compliance with this QAPP. The laboratory must ensure that personnel engaged in preparation and analysis tasks have appropriate training. As part of the audit process, the laboratory will provide written details of any method modifications planned for the consultant's review.

Planned and documented performance inspections will be conducted for field operations to assess the accuracy of the measurement systems and to determine the effectiveness of QA/QC procedures and compliance with the QAPP. Field performance inspections should be conducted by the FC.

A field inspection is not planned, but may be scheduled at the discretion of the Project QA Manager to observe and review field procedures and documentation from sample collection through packaging and shipment to the laboratories. If the Project QA Manager determines it necessary, additional inspections may be scheduled over the course of the field program. The Project Manager will be responsible for identifying an appropriate schedule of inspections prior to commencement of investigation activities.

Field inspections may be performed by the FC in accordance with written procedures or checklists. The field inspection will involve the review and evaluation of (as appropriate) implementation of approved work procedures, sampling procedures, sampling documentation; labeling, packaging, storage, and shipping of samples; completion of field records; QC compliance; subcontractor performance; and field change documentation. Field records will also be reviewed to verify that field-related activities are performed and documented in accordance with the QAPP. Items to be reviewed include, but are not limited to, field activity logs, collection forms, custody transfer forms and/or chain-of-custody forms, field measurement logs, and waste inventory logs. The FC may impose stop work order at any time if activities being conducted are determined to compromise the integrity of the program.

Preliminary results of the inspections will be reviewed with the Project Manager to ensure that deficiencies adversely affecting data quality are immediately corrected. Inspection findings will be reviewed to determine the cause of any noncompliance issues identified, schedule corrective action to prevent recurrence, evaluate the impact of the findings on completed work, and notify the FC and the Project QA Manager in an email communication of action taken or planned. The findings of the field inspection, as well as any corrective actions, will be reported to EPA as part of the Monthly Progress Reports and the Sediment Sampling and Analysis Report. The FC and the Project QA Coordinator will be responsible for verifying and documenting completion of the corrective action.

4.2 Response and Corrective Actions

The following sections identify the responsibilities of key project team members and actions to be taken in the event of an error, problem, or non-conformance to protocols identified in this document.

4.2.1 Field Activities

The FC will be responsible for correcting equipment malfunctions during the field sampling effort. The Project QA Manager will be responsible for resolving situations identified by the FC that may result in non-compliance with this QAPP. Corrective measures will be immediately documented in the field logbook.

4.2.2 Laboratory

The laboratory is required to comply with its SOPs. The Laboratory Project Manager will be responsible for ensuring that appropriate corrective actions are initiated as required for conformance with this QAPP. Laboratory personnel will be responsible for reporting problems that may compromise the quality of the data.

The Laboratory Project Manager will be notified if any QC sample result grossly exceeds the project-specified control limits and standard corrective actions do not resolve the anomaly. If the anomaly cannot be corrected, the Laboratory Project Manager will document the corrective action taken and relay this to the Project QA Manager in a timely manner, and possible additional corrective actions will be discussed. If the anomaly cannot be corrected by additional measures, the anomaly, the steps taken to identify and correct the anomaly, and the treatment of the relevant sample batch (i.e., recalculation, reanalysis, and re-extraction) will be described in the case narrative and submitted with the data package.

4.3 Reports to Management

QA reports to management include verbal status reports, written reports on field sampling activities and laboratory processes, data validation reports, data summary reports, and field and laboratory inspection and/or audit reports. These reports shall be prepared in coordination with the project team.

5 Data Validation and Usability

Laboratory data will be provided in both PDF and electronic format. Once data are received from the laboratory, QC procedures will be followed to provide an accurate evaluation of the data quality. The data will be validated in accordance with the EPA National Functional Guidelines for Data Review (EPA 2016, 2017b, 2017c) project-specific DQOs (Table B-9), analytical method criteria, and the laboratory's internal performance standards based on their SOPs.

5.1 Data Review, Validation, and Verification

During the validation process, analytical data will be evaluated for method and laboratory QC compliance, and their validity and applicability for program purposes will be determined. Based on the findings of the validation process, data validation qualifiers may be assigned. The validated project data, including qualifiers, will be entered into the project database, thus enabling this information to be retained or retrieved as needed.

5.2 Validation and Verification Methods

Data verification includes signed entries by the field and laboratory technicians on field data sheets and laboratory datasheets, respectively; review for completeness and accuracy by the FC and Laboratory Project Manager; review by the Project QA Manager for outliers and omissions; and the use of QC criteria to accept or reject specific data. Data will be entered into the EQuIS database, and a data file will be generated. A verification of the database file will be performed. One hundred percent of manually entered qualifiers will be verified. Any errors found will be corrected in the database.

Laboratory data will be reviewed and verified to determine whether DQOs have been met and that appropriate corrective actions have been taken, when necessary. The Project QA Manager or designee will be responsible for the final review of the data generated from analyses of samples.

The first level of review will take place in the laboratory as the data are generated. The laboratory department manager or designee will be responsible for ensuring that the data generated meet minimum QA/QC requirements and that the instruments were operating under acceptable conditions during data acquisition. DQOs will also be assessed at this point by comparing the results of QC measurements with pre-established criteria as a measure of data acceptability.

A Stage 4 validation will be conducted on one representative data package submitted from each laboratory, with the exception of geotechnical data. With the exceptions of the geotechnical and NAPL mobility data, Stage 2B validations will be conducted on the remainder of the data by Anchor QEA (or a subcontractor), in accordance with EPA National Functional Guidelines for Data Review (EPA 2016, 2017b, 2017c) and this QAPP, unless the Stage 4 validations reveal errors or issues that warrant additional Stage 4 validations. Stage 1 validations will be conducted on geotechnical and NAPL mobility data. Chemical and physical data will be reviewed with regard to the following, as appropriate to the particular analysis:

- Data completeness
- Holding times
- Instrument performance checks
- Initial calibrations
- Continuing calibrations
- Column confirmation results
- Equipment blanks
- Method blanks
- Surrogate recoveries
- Detection limits
- Reporting limits
- Laboratory control samples
- Field and laboratory duplicates
- MS/MSD samples
- Standard reference material results
- Interference check samples
- Serial dilutions

The results of the data validation, including text assigning qualifiers in accordance with the EPA National Functional Guidelines for Data Review (EPA 2016, 2017b, 2017c) and a tabular summary of qualifiers, will be generated by the validator and submitted to the Project QA Manager for final review and confirmation of the validity of the data.

5.3 Reconciliation with User Requirements

The Project QA Manager will review data after each survey to determine if DQOs have been met. If data do not meet the project's specifications, the Project QA Manager will review the outliers and determine if the problem is due to calibration/maintenance, sampling techniques, or other factors and will then suggest corrective action. If problems cannot be corrected by retraining, revision of techniques, or replacement of supplies or equipment, the DQOs will be reviewed for feasibility. If specific DQOs are not achievable, the Project QA Manager will consult with EPA and recommend appropriate modifications to either the laboratory or to the program requirements.

6 References

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Znidarcic, D., Abu-Hejleh, A.N., Fairbanks, T. and Robertson A., 1992, Seepage-Induced Consolidation Test; Equipment Description and Users Manual, Prepared for Florida Institute of Phosphate Research, University of Colorado, Boulder, 52 pp.

Tables

Table B-1a
Program Analyses and Rationale Summary

Program[1,2]	Analysis[3]													
	TS/TOC	**TSS**	**DOC**	**pH**	**Ignitability**	**COD**	**Metals**	**VOCs**	**PAHs**	**SVOCs**	**PCB Aroclors**	**PCB Congeners**	**Dioxin/Furans**	**LR Pesticides**
Surface Grabs	X								X			X	X	X
Depositional Surface Grabs	X						X		X	X		X	X	
Riverbank Angled Borings[3]	X						X	X	X	X	X		X	
Depth of Contamination Cores	X								X		X		X	X
Cap Model Testing	X						X	X	X					
Waste Characterization	X			X	X		X	X		X				X
Barge Dewatering		X		X			X	X		X	X			X
NAPL Mobility Testing	X													
Biogas Generation Potential	X					X			X					
Extracted NAPL														
Additional Analyses – Non PAH Analyses											X		X	X
Additional Analyses – Extended PAH	X								X					
Sediment Samples to Develop Site-Specific Equilibrium Partitioning Coefficients	X							X						
Porewater Samples to Develop Site-Specific Equilibrium Partitioning Coefficients	X		X					X						
Subsurface Porewater Samples in Contact with PTW-NAPL Sediments	X		X					X	X					
Ebullition Sheen														
Geotechnical	X													

Notes:
1. See FSP for sample collection and processing details.
2. See FSP Tables A2 and A-4 for core sampling depths.
3. See QAPP Tables 2a, 2b, 3, 4a through 4i, 5a, 5b, 6, and 7 for a complete list of analytes for each program.
4. The non-site-specific categorization is based on historical and current operations.

Table B-1a
Program Analyses and Rationale Summary

Program[1,2]	Analysis[3]											
	HR Pesticides	Herbicides	TPH/SHC	Biomarkers	TBT	Geotechnical	TCLP Metals	TCLP VOCs	TCLP SVOCs	TCLP Pesticides	TCLP Herbicides	NAPL Mobility
Surface Grabs						X						
Depositional Surface Grabs	X		X		X	X						
Riverbank Angled Borings[3]	X		X		X	X						
Depth of Contamination Cores						X						
Cap Model Testing						X						
Waste Characterization		X					X	X	X	X	X	
Barge Dewatering												
NAPL Mobility Testing						X						X
Biogas Generation Potential			X			X						
Extracted NAPL			X									
Additional Analyses – Non PAH Analyses												
Additional Analyses – Extended PAH			X	X								
Sediment Samples to Develop Site-Specific Equilibrium Partitioning Coefficients												
Porewater Samples to Develop Site-Specific Equilibrium Partitioning Coefficients												
Subsurface Porewater Samples in Contact with PTW-NAPL Sediments												
Ebullition Sheen			X									
Geotechnical						X						

Notes:
1. See FSP for sample collection and processing details.
2. See FSP Tables A2 and A-4 for core sampling depths.
3. See QAPP Tables 2a, 2b, 3, 4a through 4i, 5a, 5b, 6, and 7 for a complete list of analytes for each program.
4. The non-site-specific categorization is based on historical and current operations.

Table B-1a
Program Analyses and Rationale Summary

Program[1,2]	Rationale/Objective
Surface Grabs	Refine the Interim Project Area boundary and provide additional data density.
Depositional Surface Grabs	Characterize recent deposition in the Early Action Area pilot cap footprint.
Riverbank Angled Borings[3]	Borings to collect additional information to further evaluate the vertical and lateral extents of contamination in the riverbank and to support remedial technology evaluations.
Depth of Contamination Cores	Determine the vertical extent of depth of contamination (DOC) to allow for dredge prism development that removes the full vertical extent of contamination.
Cap Model Testing	Support capping demonstration evaluations.
Waste Characterization	Pre-characterize wastes associated with dredging to determine appropriate waste handling, transport, and final disposal classification.
Barge Dewatering	Estimate the chemical concentrations of excess water in the dredge material haul barge in contact with dredge sediments and support water quality treatment evaluations based on these concentrations
NAPL Mobility Testing	Obtain representative, relatively undisturbed sediment samples for laboratory testing of NAPL mobility.
Biogas Generation Potential	Develop input parameters for a 1D biogeochemical reactive transport model to simulate biogas production processes in sediment as a function of depth.
Extracted NAPL	Determine the physical properties of the extracted NAPL, including density, viscosity, wettability, and interfacial tension and for TPH chemical concentrations to serve as the basis for the percent mass TPH in sheen samples.
Additional Analyses – Non PAH Analyses	Include characterization for non-site-specific (i.e., non-MGP-related) contaminants[4] to document the unacceptable risks caused in the Interim Project Area.
Additional Analyses – Extended PAH	
Sediment Samples to Develop Site-Specific Equilibrium Partitioning Coefficients	Develop site-specific equilibrium partitioning coefficients for VOCs.
Porewater Samples to Develop Site-Specific Equilibrium Partitioning Coefficients	
Subsurface Porewater Samples in Contact with PTW-NAPL Sediments	Characterize porewater PAH and VOC concentrations in contact with PTW-NAPL to define cap model inputs for porewater concentrations in areas containing PTW-NAPL.
Ebullition Sheen	Assess gas ebullition-facilitated transport of PTW-NAPL.
Geotechnical	Support the site-specific remedial technology evaluations and design.

Notes:
1. See FSP for sample collection and processing details.
2. See FSP Tables A2 and A-4 for core sampling depths.
3. See QAPP Tables 2a, 2b, 3, 4a through 4i, 5a, 5b, 6, and 7 for a complete list of analytes for each program.
4. The non-site-specific categorization is based on historical and current operations.

Table B-1b
Project Contact List

QAPP Recipients	Title	Organization	Telephone Number	Email Address
—	Emergency Response Team	EPA Region 10	(206) 553-4973	—
Ryan Barth	Project Manager	Anchor QEA, LLC	(206) 903-3334	rbarth@anchorqea.com
Nik Bacher	Field Coordinator	Anchor QEA, LLC	(206) 903-3376	nbacher@anchorqea.com
Laurel Menoche	Database Manager	Anchor QEA, LLC	(360) 715-2705	lmenoche@anchorqea.com
Delaney Peterson	QA/QC Manager	Anchor QEA, LLC	(360) 715-2707	dpeterson@anchorqea.com
Darwin Thomas	Laboratory Project Manager	Apex Laboratories, LLC	(503) 718-2323	dthomas@apex-labs.com
Liz Porta	Laboratory Project Manager	Alpha Analytical, Inc.	(508) 844-4124	eporta@alphalab.com
Martha Maier	Laboratory Project Manager	Vista Analytical Laboratory, Inc.	(916) 673-1520	mmaier@vista-analytical.com
Amanda Volgardsen	Laboratory Project Manager	Analytical Resources, Inc.	(206) 695-6220	amanda.volgardsen@arilabs.com
Joe Tomei	Laboratory Project Manager	Geotesting Express	(978) 635-0424	Jtomei@geotesting.com
Larry Kunkel	Laboratory Project Manager	Core Laboratories	(713) 316-1800	eanazodo@ptslabs.com
James B. Hyzy	Laboratory Project Manager	Waste Stream Technology, Inc.	(716) 282-2469	JHyzy@sevenson.com
Dobroslav Znidarcic	Laboratory Project Manager	University of Colorado	(303) 492-7577	dobroslav.znidarcic@colorado.edu

Notes:
—: not applicable
EPA: U.S. Environmental Protection Agency
QAPP: Quality Assurance Project Plan

Table B-2a
Surface Sediment Analytes, Methods, and Targeted Reporting Limits

Parameter	Recommended Analytical Method	Site-Wide RALs[1]	PTW Thresholds[1]	ESD Site-Wide RALs and PTW Thresholds[2]	Navigation Channel RALs	MDL[3]	MRL[3]
Conventionals (%)							
Total Solids	SM 2540 G	—	—	—	—	0.10	0.10
Total Organic Carbon	SM 5310 B	—	—	—	—	0.10	0.20
Grain size	ASTM D6913 & D7928	—	—	—	—	0.10	0.20
Polycyclic Aromatic Hydrocarbons (μg/kg)							
2-Methylnaphthalene	EPA 8270D	—	—	—	—	2.67	5.33
Acenaphthene	EPA 8270D	—	—	—	—	1.33	2.67
Acenaphthylene	EPA 8270D	—	—		—	1.33	2.67
Anthracene	EPA 8270D	—	—	—	—	1.33	2.67
Benzo(a)anthracene	EPA 8270D	—	—		—	1.33	2.67
Benzo(a)pyrene	EPA 8270D	—	—	—	—	2.00	4.00
Benzo(b)fluoranthene	EPA 8270D	—	—	—	—	2.00	4.00
Benzo(g,h,i)perylene	EPA 8270D	—	—	—	—	1.33	2.67
Benzo(j)+(k)Fluoranthene	EPA 8270D	—	—	—	—	2.00	4.00
Chrysene	EPA 8270D	—	—	—	—	1.33	2.67
Dibenz(a,h)anthracene	EPA 8270D	—	—	—	—	1.33	2.67
Fluoranthene	EPA 8270D	—	—	—	—	1.33	2.67
Fluorene	EPA 8270D	—	—	—	—	1.33	2.67
Indeno(1,2,3-c,d)pyrene	EPA 8270D	—	—	—	—	1.33	2.67
Naphthalene[4]	EPA 8270D	—	140,000	—	—	2.67	5.33
Phenanthrene	EPA 8270D	—	—	—	—	1.33	2.67
Pyrene	EPA 8270D	—	—	—	—	1.33	2.67
cPAHs (BaP eq)[4,5]	—	—	106,000	774,000	—	—	—
Total PAHs[4,6,7]	—	13,000	—	30,000	170,000	—	—
Polychlorinated Biphenyl Congeners (ng/kg)							
PCB-001 - 209	EPA 1668A	—	—	—	—	9.05	10
Total PCBs[5]	--	75,000	200,000	—	1,000,000	—	—
Dioxin/Furans (ng/kg)							
2,3,7,8-TCDD	EPA 1613B	6	10	—	2	0.28	0.5
1,2,3,7,8-PeCDD	EPA 1613B	8	—	—	—	0.59	2.5
1,2,3,4,7,8-HxCDD	EPA 1613B	—	—	—	—	0.60	2.5
1,2,3,6,7,8-HxCDD	EPA 1613B	—	—	—	—	0.38	2.5
1,2,3,7,8,9-HxCDD	EPA 1613B	—	—	—	—	0.57	2.5
1,2,3,4,6,7,8-HpCDD	EPA 1613B	—	—	—	—	0.54	2.5
OCDD	EPA 1613B	—	—	—	—	1.58	5.0
2,3,7,8-TCDF	EPA 1613B	—	600	—	—	0.31	0.5
1,2,3,7,8-PeCDF	EPA 1613B	—	—	—	—	0.49	2.5
2,3,4,7,8-PeCDF	EPA 1613B	200	200	—	1,000	0.30	2.5
1,2,3,4,7,8-HxCDF	EPA 1613B	—	40	—	—	0.65	2.5
1,2,3,6,7,8-HxCDF	EPA 1613B	—	—	—	—	0.89	2.5
1,2,3,7,8,9-HxCDF	EPA 1613B	—	—	—	—	0.63	2.5
2,3,4,6,7,8-HxCDF	EPA 1613B	—	—	—	—	0.78	2.5
1,2,3,4,6,7,8-HpCDF	EPA 1613B	—	—	—	—	0.43	2.5
1,2,3,4,7,8,9-HpCDF	EPA 1613B	—	—	—	—	0.65	2.5
OCDF	EPA 1613B	—	—	—	—	0.83	5.0
2,3,7,8-TCDD eq (2005 WHO TEQ)[4]	—	—	—	—	—	—	—
Pesticides (μg/kg)							
2,4'-DDD	EPA 8081B	—	—	—	—	0.50	1.00
2,4'-DDE	EPA 8081B	—	—	—	—	0.50	1.00
2,4'-DDT	EPA 8081B	—	—	—	—	0.50	1.00
4,4'-DDD	EPA 8081B	—	—	—	—	0.50	1.00
4,4'-DDE	EPA 8081B	—	—	—	—	0.50	1.00
4,4'-DDT	EPA 8081B	—	—	—	—	0.50	1.00
DDx[4]	—	160	7,050	—	650	—	—

Notes:

1. The sediment remedial action levels and principal threat waste threshold values are presented in Table 21 of the *Record of Decision – Portland Harbor Superfund Site* (ROD; EPA 2017).
2. These values were presented in EPA's Explanation of Significant Differences (ESD; EPA 2018), which is not yet finalized. The cPAH value is the ESD PTW-highly toxic threshold and the Total PAHs value is the ESD Site-Wide RAL.
3. Actual MDLs and QLs may vary based on sample aliquot size, moisture content, and required dilution factor.
4. The naphthalene threshold value was developed for the ROD based on feasibility-level harborwide assumptions that are not applicable at the site. NW Natural is performing a site-specific capping demonstration evaluation to determine if any of the ROD Table 17 contaminants of concern containing groundwater cleanup levels cannot be reliably contained.
5. cPAH (BaP eq), total PAHs, total PCBs, 2,3,7,8-TCDD eq, and DDx are calculated values; therefore, there are no MDLs or MRLs for these parameters.
6. Total cPAH is the sum of benzo(a)pyrene equivalent concentrations, calculated by multiplying the cPAHs by their respective potency factors. cPAHs include benzo(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, indeno(1,2,3-c,d)pyrene, and dibenzo(a,h)anthracene.
7. Total PAH is the sum of 2-methylnaphthalene, acenapthene, acenaphthylene, anthracene, fluorene, naphthalene, phenanthrene, fluoranthene, pyrene, benzo(a)anthracene, chrysene, benzofluoranthenes, benzo(a)pyrene, indeno(1,2,3-c,d)pyrene, dibenzo(a,h)anthracene, and benzo(g,h,i)perylene.

—: not applicable
μg/kg: micrograms per kilogram
BaP Eq: benzo(a)pyrene equivalent
cPAH: carcinogenic polycyclic aromatic hydrocarbon
EPA: U.S. Environmental Protection Agency
MDL: method detection limit
mg/kg: milligrams per kilogram
MRL: method reporting limit
ng/kg: nanograms per kilogram
PAH: polycyclic aromatic hydrocarbon
PTW: principal threat waste
RAL: remedial action level

Table B-2b
Depositional Surface Sediment Analytes, Methods, and Targeted Reporting Limits

Parameter	Recommended Analytical Method	Cleanup Level[1]	Site-Wide RALs[2]	PTW Thresholds[2]	ESD Site-Wide RALs and PTW Thresholds[3]	Navigation Channel RALs	MDL[4]	MRL[4]
Conventionals (%)								
Total Solids	SM 2540 G	—	—	—	—	—	0.10	0.10
Total Organic Carbon	SM 5310 B	—	—	—	—	—	0.10	0.20
Grain size	ASTM D6913 & D7928	—	—	—	—	—	0.10	0.20
Metals (mg/kg)								
Arsenic	EPA 6020A	3	—	—	—	—	0.25	1.00
Cadmium	EPA 6020A	0.51	—	—	—	—	0.25	0.50
Copper	EPA 6020A	359	—	—	—	—	0.50	1.00
Lead	EPA 6020A	196	—	—	—	—	0.25	0.50
Mercury	EPA 6020A	0.085	—	—	—	—	0.040	0.080
Zinc	EPA 6020A	459	—	—	—	—	1.00	2.00
Polycyclic Aromatic Hydrocarbons (µg/kg)								
2-Methylnaphthalene	EPA 8270D	—	—	—	—	—	2.67	5.33
Acenaphthene	EPA 8270D	—	—	—	—	—	1.33	2.67
Acenaphthylene	EPA 8270D	—	—	—	—	—	1.33	2.67
Anthracene	EPA 8270D	—	—	—	—	—	1.33	2.67
Benzo(a)anthracene	EPA 8270D	—	—	—	—	—	1.33	2.67
Benzo(a)pyrene	EPA 8270D	—	—	—	—	—	2.00	4.00
Benzo(b)fluoranthene	EPA 8270D	—	—	—	—	—	2.00	4.00
Benzo(g,h,i)perylene	EPA 8270D	—	—	—	—	—	1.33	2.67
Benzo(j)+(k)Fluoranthene	EPA 8270D	—	—	—	—	—	2.00	4.00
Chrysene	EPA 8270D	—	—	—	—	—	1.33	2.67
Dibenz(a,h)anthracene	EPA 8270D	—	—	—	—	—	1.33	2.67
Fluoranthene	EPA 8270D	—	—	—	—	—	1.33	2.67
Fluorene	EPA 8270D	—	—	—	—	—	1.33	2.67
Indeno(1,2,3-c,d)pyrene	EPA 8270D	—	—	—	—	—	1.33	2.67
Naphthalene[5]	EPA 8270D	—	—	140,000	—	—	2.67	5.33
Phenanthrene	EPA 8270D	—	—	—	—	—	1.33	2.67
Pyrene	EPA 8270D	—	—	—	—	—	1.33	2.67
cPAHs (BaP eq)[5,6,7]	—	12	—	106,000	774,000	—	—	—
Total PAHs[5,6,8]	—	23,000	13,000	—	30,000	170,000	—	—
Semivolatile Organic Compounds (µg/kg)								
Bis(2-ethylhexyl)phthalate	EPA 8270D	135	—	—	—	—	20.0	40.0
Polychlorinated Biphenyl Congeners (ng/kg)								
PCB-001 - 209	EPA 1668A	—	—	—	—	—	9.05	10
Total PCBs[5,6]	--	9,000	75,000	200,000	—	1,000,000	—	—
Dioxin/Furans (ng/kg)[10]								
2,3,7,8-TCDD	EPA 1613B	0.2	6	10	—	2	0.28	0.5
1,2,3,7,8-PeCDD	EPA 1613B	0.2	8	—	—	—	0.59	2.5
1,2,3,4,7,8-HxCDD	EPA 1613B	—	—	—	—	—	0.60	2.5
1,2,3,6,7,8-HxCDD	EPA 1613B	—	—	—	—	—	0.38	2.5
1,2,3,7,8,9-HxCDD	EPA 1613B	—	—	—	—	—	0.57	2.5
1,2,3,4,6,7,8-HpCDD	EPA 1613B	—	—	—	—	—	0.54	2.5
OCDD	EPA 1613B	—	—	—	—	—	1.58	5.0
2,3,7,8-TCDF	EPA 1613B	0.40658	—	600	—	—	0.31	0.5
1,2,3,7,8-PeCDF	EPA 1613B	—	—	—	—	—	0.49	2.5
2,3,4,7,8-PeCDF	EPA 1613B	0.3	200	200	—	1,000	0.30	2.5
1,2,3,4,7,8-HxCDF	EPA 1613B	0.4	—	40	—	—	0.65	2.5
1,2,3,6,7,8-HxCDF	EPA 1613B	—	—	—	—	—	0.89	2.5
1,2,3,7,8,9-HxCDF	EPA 1613B	—	—	—	—	—	0.63	2.5
2,3,4,6,7,8-HxCDF	EPA 1613B	—	—	—	—	—	0.78	2.5
1,2,3,4,6,7,8-HpCDF	EPA 1613B	—	—	—	—	—	0.43	2.5
1,2,3,4,7,8,9-HpCDF	EPA 1613B	—	—	—	—	—	0.65	2.5
OCDF	EPA 1613B	—	—	—	—	—	0.83	5.0
2,3,7,8-TCDD eq (2005 WHO TEQ)[5,6]	—	—	—	—	—	—	—	—
High Resolution Pesticides (ng/kg)								
2,4'-DDD	EPA 1699	114,000	—	—	—	—	5.01	20
2,4'-DDE	EPA 1699	226,000	—	—	—	—	5.04	40
2,4'-DDT	EPA 1699	246,000	—	—	—	—	6.1	20
4,4'-DDD	EPA 1699	114,000	—	—	—	—	5.23	20
4,4'-DDE	EPA 1699	226,000	—	—	—	—	8.07	40
4,4'-DDT	EPA 1699	246,000	—	—	—	—	9.18	40
DDx[6]	—	6,100	160,000	7,050,000	—	650,000	—	—
Aldrin	EPA 1699	2,000	—	—	—	—	5.37	20
cis-Chlordane	EPA 1699	—	—	—	—	—	9.59	20
trans-Chlordane	EPA 1699	—	—	—	—	—	11.4	20
Oxychlordane	EPA 1699	—	—	—	—	—	11.4	20
cis-Nonachlor	EPA 1699	—	—	—	—	—	10.1	20
trans-Nonachlor	EPA 1699	—	—	—	—	—	7.6	20
Dieldrin	EPA 1699	70	—	—	—	—	10.5	20

Table B-2b
Depositional Surface Sediment Analytes, Methods, and Targeted Reporting Limits

Parameter	Recommended Analytical Method	Cleanup Level[1]	Site-Wide RALs[2]	PTW Thresholds[2]	ESD Site-Wide RALs and PTW Thresholds[3]	Navigation Channel RALs	MDL[4]	MRL[4]
Lindane	EPA 1699	5,000	—	—	—	—	7.3	20
Total Chlordanes[6,9]	—	1,400	—	—	—	—	—	—
Petroleum Hydrocarbons (mg/kg)								
Diesel range organics	NWTPHDx	91	—	—	—	—	10	20
Organometallics (µg/kg)								
Tributyltin	EPA 8270D-SIM	3,080	—	—	—	—	0.45	3.86

Notes:

1. The Riverbank Soil/Sediment Cleanup Levels are presented in Table 17 of the *Record of Decision – Portland Harbor Superfund Site* (ROD; EPA 2017).
2. The Sediment RALs and PTW Threshold Values are presented in Table 21 of the ROD (EPA 2017).
3. These values were presented in EPA's Explanation of Significant Differences (ESD; EPA 2018), which is not yet finalized. The cPAH value is the ESD PTW-highly toxic threshold and the Total PAHs value is the ESD Site-Wide RAL.
4. Actual MDLs and QLs may vary based on sample aliquot size, moisture content, and required dilution factor.
5. The naphthalene threshold value was developed for the ROD based on feasibility-level harborwide assumptions that are not applicable at the site. NW Natural is performing a site-specific capping demonstration evaluation to determine if any of the ROD Table 17 contaminants of concern containing groundwater cleanup levels cannot be reliably contained.
6. cPAH (BaP eq), total PAHs, total PCBs, 2,3,7,8-TCDD eq, DDx, and total chlordanes are calculated values; therefore, there are no MDLs or MRLs for these parameters.
7. Total cPAH is the sum of benzo(a)pyrene equivalent concentrations, calculated by multiplying the cPAHs by their respective potency factors. cPAHs include benzo(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, indeno(1,2,3-c,d)pyrene, and dibenzo(a,h)anthracene.
8. Total PAH is the sum of 2-methylnaphthalene, acenapthene, acenaphthylene, anthracene, fluorene, naphthalene, phenanthrene, fluoranthene, pyrene, benzo(a)anthracene, chrysene, benzofluoranthenes, benzo(a)pyrene, indeno(1,2,3-c,d)pyrene, dibenzo(a,h)anthracene, and benzo(g,h,i)perylene.
9. Total chlordanes are the sum of cis-chlordane, trans-chlordane, oxychlordane, cis-nonachlor, and trans-nonachlor.
10. Dioxin/furan results will be quantified to the estimated detection limit, which are calculated at the instrument using analysis-specific factors and are usually below the MDLs in the absence of matrix interference. The method chosen achieves the lowest detection limits available for this class of compounds.

—: not applicable
µg/kg: micrograms per kilogram
BaP Eq: benzo(a)pyrene equivalent
cPAH: carcinogenic polycyclic aromatic hydrocarbon
EPA: U.S. Environmental Protection Agency
MDL: method detection limit
mg/kg: milligrams per kilogram
MRL: method reporting limit
ng/kg: nanograms per kilogram
NWTPHDx: Northwest Total Petroleum Hydrocarbons - Diesel Range Extended
PTW: principal threat waste
RAL: remedial action level
SM: Standard Method

Table B-3
Riverbank Boring Soil Analytes, Methods, and Targeted Reporting Limits

Parameter	Recommended Analytical Method	Cleanup Level[1]	Site-Wide RALs[2]	PTW Thresholds[2]	ESD Site-Wide RALs and PTW Thresholds[3]	Navigation Channel RALs	MDL[4]	MRL[4]
Geotechnical								
Moisture content	ASTM D2216	—	—	—	—	—	—	—
Specific gravity	ASTM D854	—	—	—	—	—	—	—
Grain size	ASTM D6913 & D7928	—	—	—	—	—	—	—
Bulk density	ASTM D7263	—	—	—	—	—	—	—
Conventionals (%)								
Total Solids	SM 2540 G	—	—	—	—	—	0.10	0.10
Total Organic Carbon	SM 5310 B	—	—	—	—	—	0.10	0.20
Cyanide	ASTM D7511	—	—	—	—	—	0.10	0.10
Perchlorate	USEPA 6860	—	—	—	—	—	0.0005	0.000041
Metals (mg/kg)								
Arsenic	EPA 6020A	3	—	—	—	—	0.25	1.00
Cadmium	EPA 6020A	0.51	—	—	—	—	0.25	0.50
Chromium	EPA 6020A	—	—	—	—	—	0.50	1.00
Copper	EPA 6020A	359	—	—	—	—	0.50	1.00
Lead	EPA 6020A	196	—	—	—	—	0.25	0.50
Manganese	EPA 6020A	—	—	—	—	—	0.50	1.00
Mercury	EPA 6020A	0.085	—	—	—	—	0.040	0.080
Vanadium	EPA 6020A	—	—	—	—	—	0.50	1.00
Zinc	EPA 6020A	459	—	—	—	—	1.00	2.00
Volatile Organic Compounds (µg/kg)								
1,1-Dichloroethene (1,1-DCE)	EPA 8260C	—	—	—	—	—	12.5	25.0
Benzene	EPA 8260C	—	—	—	—	—	5.0	10.0
Chlorobenzene	EPA 8260C	—	—	320	—	—	12.5	25.0
cis-1,2-Dichloroethene (cis-DCE)	EPA 8260C	—	—	—	—	—	12.5	25.0
Ethylbenzene	EPA 8260C	—	—	—	—	—	12.5	25.0
Tetrachloroethene	EPA 8260C	—	—	—	—	—	12.5	25.0
Toluene	EPA 8260C	—	—	—	—	—	12.5	25.0
Trichloroethene (TCE)	EPA 8260C	—	—	—	—	—	12.5	25.0
Vinyl Chloride	EPA 8260C	—	—	—	—	—	12.5	25.0
m,p-Xylene	EPA 8260C	—	—	—	—	—	25.0	50.0
o-Xylene	EPA 8260C	—	—	—	—	—	12.5	25.0
Total Xylenes[5]	—	—	—	—	—	—	37.5	75.0
Polycyclic Aromatic Hydrocarbons (µg/kg)								
2-Methylnaphthalene	EPA 8270D SIM	—	—	—	—	—	2.67	5.33
Acenaphthene	EPA 8270D SIM	—	—	—	—	—	1.33	2.67
Acenaphthylene	EPA 8270D SIM	—	—	—	—	—	1.33	2.67
Anthracene	EPA 8270D SIM	—	—	—	—	—	1.33	2.67
Benzo(a)anthracene	EPA 8270D SIM	—	—	—	—	—	1.33	2.67
Benzo(a)pyrene	EPA 8270D SIM	—	—	—	—	—	2.00	4.00
Benzo(b)fluoranthene	EPA 8270D SIM	—	—	—	—	—	2.00	4.00
Benzo(g,h,i)perylene	EPA 8270D SIM	—	—	—	—	—	1.33	2.67
Benzo(j)+(k)Fluoranthene	EPA 8270D SIM	—	—	—	—	—	2.00	4.00
Chrysene	EPA 8270D SIM	—	—	—	—	—	1.33	2.67
Dibenz(a,h)anthracene	EPA 8270D SIM	—	—	—	—	—	1.33	2.67
Fluoranthene	EPA 8270D SIM	—	—	—	—	—	1.33	2.67
Fluorene	EPA 8270D SIM	—	—	—	—	—	1.33	2.67
Indeno(1,2,3-c,d)pyrene	EPA 8270D SIM	—	—	—	—	—	1.33	2.67
Naphthalene[5]	EPA 8270D SIM	—	—	140,000	—	—	2.67	5.33
Phenanthrene	EPA 8270D SIM	—	—	—	—	—	1.33	2.67
Pyrene	EPA 8270D SIM	—	—	—	—	—	1.33	2.67
cPAHs (BaP eq)[5,6,7]	—	12	—	106,000	774,000	—	—	—
Total PAHs[5,6,8]	—	23,000	13,000	—	30,000	170,000	—	—
Semivolatile Organic Compounds (µg/kg)								
2,4,5-Trichlorophenol	EPA 8270D	—	—	—	—	—	6.67	13.3
Bis(2-ethylhexyl)phthalate	EPA 8270D	135	—	—	—	—	20.0	40.0
Pentachlorophenol	EPA 8270D	—	—	—	—	—	13.3	26.7
PCB Aroclors (µg/kg)								
Aroclor 1016	EPA 8082A	—	—	—	—	—	0.67	1.33
Aroclor 1221	EPA 8082A	—	—	—	—	—	0.67	1.33
Aroclor 1232	EPA 8082A	—	—	—	—	—	0.67	1.33
Aroclor 1242	EPA 8082A	—	—	—	—	—	0.67	1.33
Aroclor 1248	EPA 8082A	—	—	—	—	—	0.67	1.33
Aroclor 1254	EPA 8082A	—	—	—	—	—	0.67	1.33
Aroclor 1260	EPA 8082A	—	—	—	—	—	0.67	1.33
Aroclor 1262	EPA 8082A	—	—	—	—	—	0.67	1.33
Aroclor 1268	EPA 8082A	—	—	—	—	—	0.67	1.33
Total PCB Aroclors[5,6]	—	9	75	200	—	1,000	—	—
Dioxin/Furans (ng/kg)[10]								
2,3,7,8-TCDD	EPA 1613B	0.2	6	10	—	2	0.28	0.5

Table B-3
Riverbank Boring Soil Analytes, Methods, and Targeted Reporting Limits

Parameter	Recommended Analytical Method	Cleanup Level[1]	Site-Wide RALs[2]	PTW Thresholds[2]	ESD Site-Wide RALs and PTW Thresholds[3]	Navigation Channel RALs	MDL[4]	MRL[4]
1,2,3,7,8-PeCDD	EPA 1613B	0.2	8	—	—	—	0.59	2.5
1,2,3,4,7,8-HxCDD	EPA 1613B	—	—	—	—	—	0.60	2.5
1,2,3,6,7,8-HxCDD	EPA 1613B	—	—	—	—	—	0.38	2.5
1,2,3,7,8,9-HxCDD	EPA 1613B	—	—	—	—	—	0.57	2.5
1,2,3,4,6,7,8-HpCDD	EPA 1613B	—	—	—	—	—	0.54	2.5
OCDD	EPA 1613B	—	—	—	—	—	1.58	5.0
2,3,7,8-TCDF	EPA 1613B	0.40658	—	600	—	—	0.31	0.5
1,2,3,7,8-PeCDF	EPA 1613B	—	—	—	—	—	0.49	2.5
2,3,4,7,8-PeCDF	EPA 1613B	0.3	200	200	—	1000	0.30	2.5
1,2,3,4,7,8-HxCDF	EPA 1613B	0.4	—	40	—	—	0.65	2.5
1,2,3,6,7,8-HxCDF	EPA 1613B	—	—	—	—	—	0.89	2.5
1,2,3,7,8,9-HxCDF	EPA 1613B	—	—	—	—	—	0.63	2.5
2,3,4,6,7,8-HxCDF	EPA 1613B	—	—	—	—	—	0.78	2.5
1,2,3,4,6,7,8-HpCDF	EPA 1613B	—	—	—	—	—	0.43	2.5
1,2,3,4,7,8,9-HpCDF	EPA 1613B	—	—	—	—	—	0.65	2.5
OCDF	EPA 1613B	—	—	—	—	—	0.83	5.0
2,3,7,8-TCDD eq (2005 WHO TEQ)[5,6]	—	—	—	—	—	—	—	—
Herbicides (µg/kg)								
2,4-D	EPA 8151A	--	--	--	—	--	4.29	30
High Resolution Pesticides (ng/kg)								
2,4'-DDD	EPA 1699	114,000	—	—	—	—	5.01	20
2,4'-DDE	EPA 1699	226,000	—	—	—	—	5.04	40
2,4'-DDT	EPA 1699	246,000	—	—	—	—	6.1	20
4,4'-DDD	EPA 1699	114,000	—	—	—	—	5.23	20
4,4'-DDE	EPA 1699	226,000	—	—	—	—	8.07	40
4,4'-DDT	EPA 1699	246,000	—	—	—	—	9.18	40
DDx[4]	—	6,100	160,000	7,050,000	—	650,000	—	—
Aldrin	EPA 1699	2,000	—	—	—	—	5.37	20
cis-Chlordane	EPA 1699	—	—	—	—	—	9.59	20
trans-Chlordane	EPA 1699	—	—	—	—	—	11.4	20
Oxychlordane	EPA 1699	—	—	—	—	—	11.4	20
cis-Nonachlor	EPA 1699	—	—	—	—	—	10.1	20
trans-Nonachlor	EPA 1699	—	—	—	—	—	7.6	20
Dieldrin	EPA 1699	70	—	—	—	—	10.5	20
Lindane	EPA 1699	5,000	—	—	—	—	7.3	20
Total Chlordanes[5,9]	—	1,400	—	—	—	—	—	—
Petroleum Hydrocarbons (mg/kg)								
Diesel range organics	NWTPHDx	91	—	—	—	—	10	20
Organometallics (µg/kg)								
Tributyltin	EPA 8270D-SIM	3,080	—	—	—	—	0.45	3.86

Notes:

1. The Riverbank Soil/Sediment Cleanup Levels are presented in Table 17 of the *Record of Decision – Portland Harbor Superfund Site* (ROD; EPA 2017).
2. The Sediment RALs and PTW Threshold Values are presented in Table 21 of the ROD (EPA 2017).
3. These values were presented in EPA's Explanation of Significant Differences (ESD; EPA 2018), which is not yet finalized. The cPAH value is the ESD PTW-highly toxic threshold and the Total PAHs value is the ESD Site-Wide RAL.
4. Actual MDLs and QLs may vary based on sample aliquot size, moisture content, and required dilution factor.
5. Total xylenes, cPAH (BaP eq), total PAHs,total PCBs, and DDx are calculated values; therefore, there are no MDLs or MRLs for these parameters.
6. The naphthalene threshold value was developed for the ROD based on feasibility-level harborwide assumptions that are not applicable at the site. NW Natural is performing a site-specific capping demonstration evaluation to determine if any of the ROD Table 17 contaminants of concern containing groundwater cleanup levels cannot be reliably contained.
7. Total cPAH is the sum of benzo(a)pyrene equivalent concentrations, calculated by multiplying the cPAHs by their respective potency factors. cPAHs include benzo(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, indeno(1,2,3-c,d)pyrene, and dibenzo(a,h)anthracene.
8. Total PAH is the sum of 2-methylnaphthalene, acenapthene, acenaphthylene, anthracene, fluorene, naphthalene, phenanthrene, fluoranthene, pyrene, benzo(a)anthracene, chrysene, benzofluoranthenes, benzo(a)pyrene, indeno(1,2,3-c,d)pyrene, dibenzo(a,h)anthracene, and benzo(g,h,i)perylene.
9. Total chlordanes are the sum of cis-chlordane, trans-chlordane, oxychlordane, cis-nonachlor, and trans-nonachlor.
10. Dioxin/furan results will be quantified to the estimated detection limit, which are calculated at the instrument using analysis-specific factors and are usually below the MDLs in the absence of matrix interference. The method chosen achieves the lowest detection limits available for this class of compounds.

—: not applicable
µg/kg: micrograms per kilogram
ASTM: ASTM International
BaP Eq: benzo(a)pyrene equivalent
cPAH: carcinogenic polycyclic aromatic hydrocarbon
EPA: U.S. Environmental Protection Agency
MDL: method detection limit
mg/kg: milligrams per kilogram
MRL: method reporting limit
ng/kg: nanograms per kilogram
PTW: principal threat waste
RAL: remedial action level
SM: Standard Method

Table B-4a
Depth of Contamination Subsurface Sediment Analytes, Methods, and Targeted Reporting Limits

Parameter	Recommended Analytical Method	Site-Wide RALs[1]	PTW Thresholds[1]	ESD Site-Wide RALs and PTW Thresholds[2]	Navigation Channel RALs[1]	MDL[3]	MRL[3]
Geotechnical							
Moisture content	ASTM D2216	—	—	—	—	—	—
Specific gravity	ASTM D854	—	—	—	—	—	—
Grain size	ASTM D6913 & D7928	—	—	—	—	—	—
Atterberg limits	ASTM D4318	—	—	—	—	—	—
Conventionals (%)							
Total Solids	SM 2540 G	—	—	—	—	0.10	0.10
Total Organic Carbon	SM 5310 B	—	—	—	—	0.10	0.20
Polycyclic Aromatic Hydrocarbons (µg/kg)							
2-Methylnaphthalene	EPA 8270D	—	—	—	—	2.67	5.33
Acenaphthene	EPA 8270D	—	—	—	—	1.33	2.67
Acenaphthylene	EPA 8270D	—	—	—	—	1.33	2.67
Anthracene	EPA 8270D	—	—	—	—	1.33	2.67
Benzo(a)anthracene	EPA 8270D	—	—	—	—	1.33	2.67
Benzo(a)pyrene	EPA 8270D	—	—	—	—	2.00	4.00
Benzo(b)fluoranthene	EPA 8270D	—	—	—	—	2.00	4.00
Benzo(g,h,i)perylene	EPA 8270D	—	—	—	—	1.33	2.67
Benzo(j)+(k)Fluoranthene	EPA 8270D	—	—	—	—	2.00	4.00
Chrysene	EPA 8270D	—	—	—	—	1.33	2.67
Dibenz(a,h)anthracene	EPA 8270D	—	—	—	—	1.33	2.67
Fluoranthene	EPA 8270D	—	—	—	—	1.33	2.67
Fluorene	EPA 8270D	—	—	—	—	1.33	2.67
Indeno(1,2,3-c,d)pyrene	EPA 8270D	—	—	—	—	1.33	2.67
Naphthalene[4]	EPA 8270D	—	140,000	—	—	2.67	5.33
Phenanthrene	EPA 8270D	—	—	—	—	1.33	2.67
Pyrene	EPA 8270D	—	—	—	—	1.33	2.67
cPAHs (BaP eq)[4,5,6]	—	—	106,000	774,000	—	—	—
Total PAHs[4,5,7]	—	13,000	—	30,000	170,000	—	—
PCB Aroclors (µg/kg)							
Aroclor 1016	EPA 8082A	—	—	—	—	0.67	1.33
Aroclor 1221	EPA 8082A	—	—	—	—	0.67	1.33
Aroclor 1232	EPA 8082A	—	—	—	—	0.67	1.33
Aroclor 1242	EPA 8082A	—	—	—	—	0.67	1.33
Aroclor 1248	EPA 8082A	—	—	—	—	0.67	1.33
Aroclor 1254	EPA 8082A	—	—	—	—	0.67	1.33
Aroclor 1260	EPA 8082A	—	—	—	—	0.67	1.33
Aroclor 1262	EPA 8082A	—	—	—	—	0.67	1.33
Aroclor 1268	EPA 8082A	—	—	—	—	0.67	1.33
Total PCB Aroclors[4,5]	—	75	200	—	1,000	—	—
Dioxin/Furans (ng/kg)							
2,3,7,8-TCDD	EPA 1613B	6	10	—	2	0.28	0.5
1,2,3,7,8-PeCDD	EPA 1613B	8	—	—	—	0.59	2.5
1,2,3,4,7,8-HxCDD	EPA 1613B	—	—	—	—	0.60	2.5
1,2,3,6,7,8-HxCDD	EPA 1613B	—	—	—	—	0.38	2.5
1,2,3,7,8,9-HxCDD	EPA 1613B	—	—	—	—	0.57	2.5
1,2,3,4,6,7,8-HpCDD	EPA 1613B	—	—	—	—	0.54	2.5
OCDD	EPA 1613B	—	—	—	—	1.58	5.0
2,3,7,8-TCDF	EPA 1613B	—	600	—	—	0.31	0.5
1,2,3,7,8-PeCDF	EPA 1613B	—	—	—	—	0.49	2.5
2,3,4,7,8-PeCDF	EPA 1613B	200	200	—	1,000	0.30	2.5
1,2,3,4,7,8-HxCDF	EPA 1613B	—	40	—	—	0.65	2.5
1,2,3,6,7,8-HxCDF	EPA 1613B	—	—	—	—	0.89	2.5
1,2,3,7,8,9-HxCDF	EPA 1613B	—	—	—	—	0.63	2.5
2,3,4,6,7,8-HxCDF	EPA 1613B	—	—	—	—	0.78	2.5
1,2,3,4,6,7,8-HpCDF	EPA 1613B	—	—	—	—	0.43	2.5
1,2,3,4,7,8,9-HpCDF	EPA 1613B	—	—	—	—	0.65	2.5
OCDF	EPA 1613B	—	—	—	—	0.83	5.0
2,3,7,8-TCDD eq (2005 WHO TEQ)[4,5]	—	—	—	—	—	—	—
Low Resolution Pesticides (µg/kg)							
2,4'-DDD	EPA 8081B	—	—	—	—	0.50	1.00
2,4'-DDE	EPA 8081B	—	—	—	—	0.50	1.00
2,4'-DDT	EPA 8081B	—	—	—	—	0.50	1.00
4,4'-DDD	EPA 8081B	—	—	—	—	0.50	1.00
4,4'-DDE	EPA 8081B	—	—	—	—	0.50	1.00
4,4'-DDT	EPA 8081B	—	—	—	—	0.50	1.00
DDx[5]	—	160	7,050	—	650	—	—

Table B-4a
Depth of Contamination Subsurface Sediment Analytes, Methods, and Targeted Reporting Limits

Notes:

1. The Sediment RALs and PTW Threshold Values are presented in Table 21 of the *Record of Decision – Portland Harbor Superfund Site* (ROD; EPA 2017).
2. These values were presented in EPA's Explanation of Significant Differences (ESD; EPA 2018), which is not yet finalized. The cPAH value is the ESD PTW-highly toxic threshold and the Total PAHs value is the ESD Site-Wide RAL.
3. Actual MDLs and QLs may vary based on sample aliquot size, moisture content, and required dilution factor.
4. The naphthalene threshold value was developed for the ROD based on feasibility-level harborwide assumptions that are not applicable at the site. NW Natural is performing a site-specific capping demonstration evaluation to determine if any of the ROD Table 17 COCs containing groundwater cleanup levels cannot be reliably contained.
5. cPAH (BaP eq), total PAHs, total PCBs, 2,3,7,8-TCDD eq, and DDx are calculated values; therefore, there are no MDLs or MRLs for these parameters.
6. Total cPAH is the sum of benzo(a)pyrene equivalent concentrations, calculated by multiplying the cPAHs by their respective potency factors. cPAHs include benzo(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, indeno(1,2,3-c,d)pyrene, and dibenzo(a,h)anthracene.
7. Total PAH is the sum of 2-methylnaphthalene, acenapthene, acenaphthylene, anthracene, fluorene, naphthalene, phenanthrene, fluoranthene, pyrene, benzo(a)anthracene, chrysene, benzofluoranthenes, benzo(a)pyrene, indeno(1,2,3-c,d)pyrene, dibenzo(a,h)anthracene, and benzo(g,h,i)perylene.

—: not applicable
µg/kg: micrograms per kilogram
ASTM: ASTM International
BaP Eq: benzo(a)pyrene equivalent
cPAH: carcinogenic polycyclic aromatic hydrocarbon
EPA: U.S. Environmental Protection Agency
MDL: method detection limit
mg/kg: milligrams per kilogram
MRL: method reporting limit
ng/kg: nanograms per kilogram
PTW: principal threat waste
RAL: remedial action level
SM: Standard Method

Table B-4b
Porewater Concentrations Calculated from Bulk Subsurface Sediment Analytes, Methods, and Targeted Reporting Limits

Parameter	Recommended Analytical Method	Cleanup Level[1]	ROD Site-Wide RALs[2]	PTW Thresholds[2]	ESD Site-Wide RALs and PTW Thresholds[3]	Navigation Channel RALs	MDL[4]	MRL[4]
Geotechnical								
Moisture content	ASTM D2216	—	—	—	—	—	—	—
Specific gravity	ASTM D854	—	—	—	—	—	—	—
Grain size	ASTM D6913 & D7928	—	—	—	—	—	—	—
Atterberg limits	ASTM D4318	—	—	—	—	—	—	—
Conventionals (%)								
Total Solids	SM 2540 G	—	—	—	—	—	0.10	0.10
Total Organic Carbon	SM 5310 B	—	—	—	—	—	0.10	0.20
Metals (mg/kg)								
Arsenic	EPA 6020A	3	—	—	—	—	0.25	1.0
Volatile Organic Compounds (µg/kg)								
1,1-Dichloroethene (1,1-DCE)	EPA 8260C	—	—	—	—	—	12.5	25.0
Benzene	EPA 8260C	—	—	—	—	—	5.0	10.0
Chlorobenzene	EPA 8260C	—	—	320	—	—	12.5	25.0
cis-1,2-Dichloroethene (cis-DCE)	EPA 8260C	—	—	—	—	—	12.5	25.0
Ethylbenzene	EPA 8260C	—	—	—	—	—	12.5	25.0
Tetrachloroethene	EPA 8260C	—	—	—	—	—	12.5	25.0
Toluene	EPA 8260C	—	—	—	—	—	12.5	25.0
Trichloroethene (TCE)	EPA 8260C	—	—	—	—	—	12.5	25.0
Vinyl Chloride	EPA 8260C	—	—	—	—	—	12.5	25.0
m,p-Xylene	EPA 8260C	—	—	—	—	—	25.0	50.0
o-Xylene	EPA 8260C	—	—	—	—	—	12.5	25.0
Total Xylenes[5]	—	—	—	—	—	—	37.5	75.0
Polycyclic Aromatic Hydrocarbons (µg/kg)								
2-Methylnaphthalene	EPA 8270D	—	—	—	—	—	2.7	5.3
Acenaphthene	EPA 8270D	—	—	—	—	—	1.3	2.7
Acenaphthylene	EPA 8270D	—	—	—	—	—	1.3	2.7
Anthracene	EPA 8270D	—	—	—	—	—	1.3	2.7
Benzo(a)anthracene	EPA 8270D	—	—	—	—	—	1.3	2.7
Benzo(a)pyrene	EPA 8270D	—	—	—	—	—	2.0	4.0
Benzo(b)fluoranthene	EPA 8270D	—	—	—	—	—	2.0	4.0
Benzo(g,h,i)perylene	EPA 8270D	—	—	—	—	—	1.3	2.7
Benzo(j)+(k)Fluoranthene	EPA 8270D	—	—	—	—	—	2.0	4.0
Chrysene	EPA 8270D	—	—	—	—	—	1.3	2.7
Dibenz(a,h)anthracene	EPA 8270D	—	—	—	—	—	1.3	2.7
Fluoranthene	EPA 8270D	—	—	—	—	—	1.3	2.7
Fluorene	EPA 8270D	—	—	—	—	—	1.3	2.7
Indeno(1,2,3-c,d)pyrene	EPA 8270D	—	—	—	—	—	1.3	2.7
Naphthalene[6]	EPA 8270D	—	—	140,000	—	—	2.7	5.3
Phenanthrene	EPA 8270D	—	—	—	—	—	1.3	2.7
Pyrene	EPA 8270D	—	—	—	—	—	1.3	2.7
cPAHs (BaP eq)[5,6,7]	—	12	—	106,000	774,000	—	—	—
Total PAHs[5,6,8]	—	23,000	13,000	—	30,000	170,000	—	—

Notes:

1. The Riverbank Soil/Sediment Cleanup Levels are presented in Table 17 of the *Record of Decision – Portland Harbor Superfund Site* (ROD; EPA 2017).
2. The Sediment RALs and PTW Threshold Values are presented in Table 21 of the ROD (EPA 2017).
3. These values were presented in EPA's Explanation of Significant Differences (ESD; EPA 2018), which is not yet finalized. The cPAH value is the ESD PTW-highly toxic threshold and the Total PAHs value is the ESD Site-Wide RAL.
4. Actual MDLs and QLs may vary based on sample aliquot size, moisture content, and required dilution factor.
5. Total xylenes, cPAH (BaP eq), and total PAHs are calculated values; therefore, there are no MDLs or MRLs for these parameters.
6. The naphthalene threshold value was developed for the ROD based on feasibility-level harborwide assumptions that are not applicable at the site. NW Natural is performing a site-specific capping demonstration evaluation to determine if any of the ROD Table 17 contaminants of concern containing groundwater cleanup levels cannot be reliably contained.
7. Total cPAH is the sum of benzo(a)pyrene equivalent concentrations, calculated by multiplying the cPAHs by their respective potency factors. cPAHs include benzo(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, indeno(1,2,3-c,d)pyrene, and dibenzo(a,h)anthracene.
8. Total PAH is the sum of 2-methylnaphthalene, acenapthene, acenaphthylene, anthracene, fluorene, naphthalene, phenanthrene, fluoranthene, pyrene, benzo(a)anthracene, chrysene, benzofluoranthenes, benzo(a)pyrene, indeno(1,2,3-c,d)pyrene, dibenzo(a,h)anthracene, and benzo(g,h,i)perylene.

—: not applicable
µg/kg: micrograms per kilogram
ASTM: ASTM International
BaP Eq: benzo(a)pyrene equivalent
cPAH: carcinogenic polycyclic aromatic hydrocarbon
EPA: U.S. Environmental Protection Agency
MDL: method detection limit
mg/kg: milligrams per kilogram
MRL: method reporting limit
ng/kg: nanograms per kilogram
PTW: principal threat waste
RAL: remedial action level
SM: Standard Method

Table B-4c
Dredge Material and Riverbank Waste Suitability Analytes, Methods, and Targeted Reporting Limits

Parameter	Recommended Analytical Method	MDL[1]	MRL[1]
Conventionals (mg/kg)			
pH (SU)	EPA 9045D	—	—
Ignitablility (°)	EPA 1030	—	—
Total Solids (%)	SM 2540 G	0.10	0.10
Metals (mg/kg)			
Arsenic	EPA 6020A	0.25	1.00
Barium	EPA 6020A	0.50	1.00
Cadmium	EPA 6020A	0.25	0.50
Chromium	EPA 6020A	0.50	1.00
Lead	EPA 6020A	0.25	0.50
Mercury	EPA 6020A	0.040	0.080
Selenium	EPA 6020A	0.25	0.50
Silver	EPA 6020A	0.05	0.10
Volatile Organic Compounds (µg/kg)			
1,1-Dichloroethene (1,1-DCE)	EPA 8260C	12.5	25.0
1,2-Dichloroethane	EPA 8260C	12.5	25
1,4-Dichlorobenzene	EPA 8260C	12.5	25
2-Butanone	EPA 8260C	250	500
Benzene	EPA 8260C	5.0	10.0
Carbon tetrachloride	EPA 8260C	25	50
Chlorobenzene	EPA 8260C	12.5	25.0
Chloroform	EPA 8260C	25	50
cis-1,2-Dichloroethene (cis-DCE)	EPA 8260C	12.5	25.0
Ethylbenzene	EPA 8260C	12.5	25.0
m,p-Xylene	EPA 8260C	25.0	50.0
o-Xylene	EPA 8260C	12.5	25.0
Tetrachloroethene	EPA 8260C	12.5	25.0
Toluene	EPA 8260C	12.5	25.0
Total Xylenes[2]	—	37.5	75.0
trans-1,2-Dichloroethene (trans-DCE)	EPA 8260C	12.5	25.0
Trichloroethene (TCE)	EPA 8260C	12.5	25.0
Vinyl Chloride	EPA 8260C	12.5	25.0
Semivolatile Organic Compounds (µg/kg)			
2,4,5-Trichlorophenol	EPA 8270D	6.67	13.3
2,4,6-Trichlorophenol	EPA 8270D	6.67	13.3
2,4-Dinitrotoluene	EPA 8270D	13.3	26.7
2-Methylphenol	EPA 8270D	3.33	6.7
3- & 4-Methylphenol	EPA 8270D	3.33	6.7
Hexachlorobenzene	EPA 8270D	1.33	2.67
Hexachlorobutadiene	EPA 8270D	3.33	6.67
Hexachloroethane	EPA 8270D	3.33	6.67
Nitrobenzene	EPA 8270D	13.3	26.7
Pentachlorophenol	EPA 8270D	13.3	26.7
Phenol	EPA 8270D	2.67	5.3
Pyridine	EPA 8270D	6.67	13.3
Pesticides (µg/kg)			
Lindane	EPA 8081B	0.5	1.0
Heptachlor	EPA 8081B	0.5	1.0
Heptachlor epoxide	EPA 8081B	0.5	1.0
Endrin	EPA 8081B	0.5	1.0
Methoxychlor	EPA 8081B	1.5	3
Toxaphene	EPA 8081B	15	30
Chlordane	EPA 8081B	15	30
Herbicides (µg/kg)			
2,4-D	EPA 8151A	4.29	30
2,4,5-TP (Silvex)	EPA 8151A	6.48	20
TCLP Metals (mg/L)			
Arsenic	EPA 6020A	0.05	0.10
Barium	EPA 6020A	2.5	5.00
Cadmium	EPA 6020A	0.05	0.10
Chromium	EPA 6020A	0.05	0.10
Lead	EPA 6020A	0.025	0.05
Mercury	EPA 6020A	0.0035	0.007
Selenium	EPA 6020A	0.05	0.10
Silver	EPA 6020A	0.05	0.10
TCLP VOCs (mg/L)			
Benzene	EPA 8260C	0.00625	0.0125
Carbon tetrachloride	EPA 8260C	0.0125	0.025
Chlorobenzene	EPA 8260C	0.0125	0.025
Chloroform	EPA 8260C	0.025	0.05
1,2-Dichloroethane	EPA 8260C	0.0125	0.025
1,1-Dichloroethene	EPA 8260C	0.0125	0.025

Table B-4c
Dredge Material and Riverbank Waste Suitability Analytes, Methods, and Targeted Reporting Limits

Parameter	Recommended Analytical Method	MDL[1]	MRL[1]
1,4-Dichlorobenzene	EPA 8260C	0.0125	0.025
2-Butanone	EPA 8260C	0.25	0.5
Tetrachloroethene	EPA 8260C	0.0125	0.025
Trichloroethene	EPA 8260C	0.0125	0.025
Vinyl chloride	EPA 8260C	0.0125	0.025
TCLP SVOCs (mg/L)			
2,4,5-Trichlorophenol	EPA 8270D	0.0025	0.005
2,4,6-Trichlorophenol	EPA 8270D	0.0025	0.005
2,4-Dinitrotoluene	EPA 8270D	0.001	0.002
2-Methylphenol	EPA 8270D	0.0025	0.005
3- & 4-Methylphenol	EPA 8270D	0.0025	0.005
Hexachlorobenzene	EPA 8270D	0.001	0.002
Hexachlorobutadiene	EPA 8270D	0.0025	0.005
Hexachloroethane	EPA 8270D	0.0025	0.005
Nitrobenzene	EPA 8270D	0.0025	0.005
Pentachlorophenol	EPA 8270D	0.005	0.01
Pyridine	EPA 8270D	0.005	0.01
TCLP Pesticides (mg/L)			
Lindane	EPA 8081B	0.000075	0.00015
Heptachlor	EPA 8081B	0.000075	0.00015
Heptachlor epoxide	EPA 8081B	0.000075	0.00015
Endrin	EPA 8081B	0.000075	0.00015
Methoxychlor	EPA 8081B	0.000075	0.00015
Toxaphene	EPA 8081B	0.000075	0.00015
Chlordane	EPA 8081B	0.000075	0.00015
TCLP Herbicides (mg/L)			
2,4-D	EPA 8151A	0.000408	0.002
2,4,5-TP (Silvex)	EPA 8151A	0.000117	0.0006

Notes:

1. Actual MDLs and QLs may vary based on sample aliquot size, moisture content, and required dilution factor.
2. Total xylenes are calculated values; therefore, there are no MDLs or MRLs for these parameters.
   Record of Decision - Portland Harbor Superfund Site (EPA 2017) Table 17 Groundwater COC.

—: not applicable
µg/kg: micrograms per kilogram
EPA: U.S. Environmental Protection Agency
MDL: method detection limit
mg/kg: milligrams per kilogram
mg/L: milligrams per liter
MRL: method reporting limit
ng/kg: nanograms per kilogram
SM: Standard Method

Table B-4d

Barge Dewatering Dredge Elutriate Test Analytes, Methods, and Targeted Reporting Limits

Analyte	Analytical Method	Method Detection Limit[1]	Target Reporting Limit[1]
Conventionals			
pH (SU)	SM 9040C	0.1	0.1
Total Suspended Solids (mg/L)	SM 2540 D	5.0	5.0
Metals (µg/L)			
Arsenic	EPA 6020A	0.5	1.0
Chromium	EPA 6020A	0.5	1.0
Copper	EPA 6020A	0.5	1.0
Zinc	EPA 6020A	2.0	4.0
Semivolatile organic compounds (SVOCs) (µg/L)			
Benz(a)anthracene	EPA 8270D	0.01	0.02
Benzo(a)pyrene	EPA 8270D	0.015	0.03
Benzo(b)fluoranthene	EPA 8270D	0.015	0.03
Benzo(k)fluoranthene	EPA 8270D	0.015	0.03
Chrysene	EPA 8270D	0.01	0.02
Dibenz(a,h)anthracene	EPA 8270D	0.01	0.02
Indeno(1,2,3-cd)pyrene	EPA 8270D	0.01	0.02
Naphthalene	EPA 8270D	0.02	0.04
Pentachlorophenol (PCP)	EPA 8270D	0.1	0.2
Bis(2-ethylhexyl)phthalate	EPA 8270D	0.2	0.4
Hexachlorobenzene	EPA 8270D	0.01	0.02
VOCs (µg/L)			
Ethylbenzene	EPA 8260C	0.25	0.5
Polychlorinated Biphenyl Aroclors (µg/L)			
Aroclor 1016	EPA 8082A	0.01	0.02
Aroclor 1221	EPA 8082A	0.01	0.02
Aroclor 1232	EPA 8082A	0.01	0.02
Aroclor 1242	EPA 8082A	0.01	0.02
Aroclor 1248	EPA 8082A	0.01	0.02
Aroclor 1254	EPA 8082A	0.01	0.02
Aroclor 1260	EPA 8082A	0.01	0.02
Pesticides (µg/L)			
Aldrin	EPA 8081B	0.005	0.01
cis-Chlordane	EPA 8081B	0.005	0.01
trans-Chlordane	EPA 8081B	0.005	0.01
2,4'-DDD	EPA 8081B	0.005	0.01
2,4'-DDE	EPA 8081B	0.005	0.01
2,4'-DDT	EPA 8081B	0.005	0.01
cis-Nonachlor	EPA 8081B	0.005	0.01
trans-Nonachlor	EPA 8081B	0.005	0.01
Oxychlordane	EPA 8081B	0.005	0.01

Table B-4d

Barge Dewatering Dredge Elutriate Test Analytes, Methods, and Targeted Reporting Limits

Analyte	Analytical Method	Method Detection Limit[1]	Target Reporting Limit[1]
4,4'-DDD	EPA 8081B	0.005	0.01
4,4'-DDE	EPA 8081B	0.005	0.01
4,4'-DDT	EPA 8081B	0.005	0.01

Notes:
1. Actual MDLs and QLs may vary based on sample aliquot size and required dilution factor.

µg/L: micrograms per liter
EPA: U.S. Environmental Protection Agency
mg/L: milligrams per liter
SU: standard units

Table B-4e
Nonaqueous Phase Liquid Mobility Testing Analytes, Methods, and Targeted Reporting Limits

Parameter	Recommended Analytical Method	MDL[1]	MRL[1]
Geotechnical			
Grain size	ASTM D6913 & D7928	—	—
Bulk density	ASTM D7263	—	—
NAPL Mobility Testing[2]			
Core slabbing and preparation	API RP40	—	—
Core photography with white light and UV	ASTM D5079	—	—
Free product mobility via centrifuge	ASTM D425	—	—
Pore fluid saturations (NAPL and water)	API RP40	—	—
Grain density	API RP40	—	—
Fluid density/specific gravity	ASTM D1481	—	—
Porosity	API RP40	—	—
Vertical permeability	API RP40	—	—
Capillary pressure	ASTM D6836	—	—
Viscosity	ASTM D445	—	—
Interfacial tension	ASTM D971	—	—
Dry bulk density	EPA Method 9100	—	—
Hydraulic conductivity	ASTMD 5084	—	—
Wettability (droplet method)	Cohen and Mercer 1993	—	—
Conventionals (%)			
Total Solids	SM 2540 G	0.10	0.10
Total Organic Carbon	SM 5310 B	0.10	0.20

Notes:
1. Actual MDLs and QLs may vary based on sample aliquot size, moisture content, and required dilution factor.
2. Nonaqueous phase liquid mobility analyses will depend on Stage 1 mobility test results and some methods listed may not be utilized.
--: not applicable
µg/kg: micrograms per kilogram
ASTM: ASTM International
EPA: U.S. Environmental Protection Agency
MDL: method detection limit
MRL: method reporting limit
SM: Standard Method

Table B-4f

Biogas Generation Potential Analytes, Methods, and Targeted Reporting Limits

Parameter	Recommended Analytical Method	MDL[1]	MRL[1]
Geotechnical			
Moisture content	ASTM D2216	—	—
Grain size	ASTM D6913 & D7928	—	—
Conventionals (mg/kg)			
Total Organic Carbon (mg/kg)	SM 5310 B	100	200
Chemical Oxygen Demand	SM 5220 D	TBD	TBD
PAHs and Alkylated PAHs (µg/kg)			
Acenaphthene	EPA 8270D SIM Modified	1.33	2.67
Acenaphthylene	EPA 8270D SIM Modified	1.33	2.67
Anthracene	EPA 8270D SIM Modified	1.33	2.67
Benzo(a)anthracene	EPA 8270D SIM Modified	1.33	2.67
Benzo(a)pyrene	EPA 8270D SIM Modified	2.00	4.00
Benzo(a)fluoranthene	EPA 8270D SIM Modified	0.20	1.01
Benzo(b)fluoranthene	EPA 8270D SIM Modified	2.00	4.00
Benzo(g,h,i)perylene	EPA 8270D SIM Modified	1.33	2.67
Benzo(j)+(k)Fluoranthene	EPA 8270D SIM Modified	2.00	4.00
Chrysene	EPA 8270D SIM Modified	1.33	2.67
Dibenz(a,h)+(a,c)anthracene	EPA 8270D SIM Modified	1.33	2.67
Fluoranthene	EPA 8270D SIM Modified	1.33	2.67
Fluorene	EPA 8270D SIM Modified	1.33	2.67
Indeno(1,2,3-c,d)pyrene	EPA 8270D SIM Modified	1.33	2.67
Naphthalene	EPA 8270D SIM Modified	2.67	5.33
Phenanthrene	EPA 8270D SIM Modified	1.33	2.67
Pyrene	EPA 8270D SIM Modified	1.33	2.67
Cis/Trans-Decalin	EPA 8270D SIM Modified	0.252	0.50
C1-Decalins	EPA 8270D SIM Modified	0.252	1.01
C2-Decalins	EPA 8270D SIM Modified	0.252	1.01
C3-Decalins	EPA 8270D SIM Modified	0.252	1.01
C4-Decalins	EPA 8270D SIM Modified	0.252	1.01
C1-Naphthalenes	EPA 8270D SIM Modified	0.289	1.01
C2-Naphthalenes	EPA 8270D SIM Modified	0.289	1.01
C3-Naphthalenes	EPA 8270D SIM Modified	0.289	1.01
C4-Naphthalenes	EPA 8270D SIM Modified	0.289	1.01
2-Methylnaphthalene	EPA 8270D SIM Modified	0.259	1.01
1-Methylnaphthalene	EPA 8270D SIM Modified	0.317	1.01
Benzothiophene	EPA 8270D SIM Modified	0.315	1.01
C1-Benzo(b)thiophenes	EPA 8270D SIM Modified	0.315	1.01
C2-Benzo(b)thiophenes	EPA 8270D SIM Modified	0.315	1.01
C3-Benzo(b)thiophenes	EPA 8270D SIM Modified	0.315	1.01
C4-Benzo(b)thiophenes	EPA 8270D SIM Modified	0.315	1.01
Biphenyl	EPA 8270D SIM Modified	0.311	1.01
2,6-Dimethylnaphthalene	EPA 8270D SIM Modified	0.239	1.01

Table B-4f
Biogas Generation Potential Analytes, Methods, and Targeted Reporting Limits

Parameter	Recommended Analytical Method	MDL[1]	MRL[1]
Dibenzofuran	EPA 8270D SIM Modified	0.317	1.01
2,3,5-Trimethylnaphthalene	EPA 8270D SIM Modified	0.164	1.01
C1-Fluorenes	EPA 8270D SIM Modified	0.268	1.01
C2-Fluorenes	EPA 8270D SIM Modified	0.268	1.01
C3-Fluorenes	EPA 8270D SIM Modified	0.268	1.01
Dibenzothiophene	EPA 8270D SIM Modified	0.277	1.01
4-Methyldibenzothiophene(4MDT)	EPA 8270D SIM Modified	0.277	1.01
2/3-Methyldibenzothiophene(2MDT)	EPA 8270D SIM Modified	0.277	1.01
1-Methyldibenzothiophene(1MDT)	EPA 8270D SIM Modified	0.277	1.01
C1-Dibenzothiophenes	EPA 8270D SIM Modified	0.277	1.01
C2-Dibenzothiophenes	EPA 8270D SIM Modified	0.277	1.01
C3-Dibenzothiophenes	EPA 8270D SIM Modified	0.277	1.01
C4-Dibenzothiophenes	EPA 8270D SIM Modified	0.277	1.01
3-Methylphenanthrene (3MP)	EPA 8270D SIM Modified	0.333	1.01
2-Methylphenanthrene (2MP)	EPA 8270D SIM Modified	0.333	1.01
2-Methylanthracene (2MA)	EPA 8270D SIM Modified	0.333	1.01
9/4-Methylphenanthrene (9MP)	EPA 8270D SIM Modified	0.333	1.01
1-Methylphenanthrene (1MP)	EPA 8270D SIM Modified	0.333	1.01
C1-Phenanthrenes/Anthracenes	EPA 8270D SIM Modified	0.333	1.01
C2-Phenanthrenes/Anthracenes	EPA 8270D SIM Modified	0.333	1.01
C3-Phenanthrenes/Anthracenes	EPA 8270D SIM Modified	0.333	1.01
C4-Phenanthrenes/Anthracenes	EPA 8270D SIM Modified	0.333	1.01
Retene	EPA 8270D SIM Modified	0.247	1.01
Carbazole	EPA 8270D SIM Modified	0.329	1.01
Benzo(b)fluorene	EPA 8270D SIM Modified	0.291	1.01
7H-Benzo(c)fluorene	EPA 8270D SIM Modified	0.291	1.01
2-Methylpyrene	EPA 8270D SIM Modified	0.264	1.01
4-Methylpyrene	EPA 8270D SIM Modified	0.264	1.01
1-Methylpyrene	EPA 8270D SIM Modified	0.264	1.01
C1-Fluoranthenes/Pyrenes	EPA 8270D SIM Modified	0.264	1.01
C2-Fluoranthenes/Pyrenes	EPA 8270D SIM Modified	0.264	1.01
C3-Fluoranthenes/Pyrenes	EPA 8270D SIM Modified	0.264	1.01
C4-Fluoranthenes/Pyrenes	EPA 8270D SIM Modified	0.264	1.01
Naphthobenzothiophene	EPA 8270D SIM Modified	0.281	1.01
C1-Naphthobenzothiophenes	EPA 8270D SIM Modified	0.281	1.01
C2-Naphthobenzothiophenes	EPA 8270D SIM Modified	0.281	1.01
C3-Naphthobenzothiophenes	EPA 8270D SIM Modified	0.281	1.01
C4-Naphthobenzothiophenes	EPA 8270D SIM Modified	0.281	1.01
C1-Chrysenes	EPA 8270D SIM Modified	0.203	1.01
C2-Chrysenes	EPA 8270D SIM Modified	0.203	1.01
C3-Chrysenes	EPA 8270D SIM Modified	0.203	1.01
C4-Chrysenes	EPA 8270D SIM Modified	0.203	1.01

Table B-4f

Biogas Generation Potential Analytes, Methods, and Targeted Reporting Limits

Parameter	Recommended Analytical Method	MDL[1]	MRL[1]
Benzo(e)pyrene	EPA 8270D SIM Modified	0.207	1.01
Perylene	EPA 8270D SIM Modified	0.194	1.01
Saturated Hydrocarbons (mg/kg)			
Isoprenoid RRT 1380	EPA 8015D Modified	0.011	0.033
Isoprenoid RRT 1470	EPA 8015D Modified	0.011	0.033
n-Decane	EPA 8015D Modified	0.0148	0.0445
n-Docosane	EPA 8015D Modified	0.011	0.033
n-Dodecane	EPA 8015D Modified	0.011	0.033
n-Dotriacontane	EPA 8015D Modified	0.013	0.033
n-Eicosane	EPA 8015D Modified	0.012	0.033
n-Heneicosane	EPA 8015D Modified	0.011	0.033
n-Hentriacontane	EPA 8015D Modified	0.0162	0.0486
n-Heptacosane	EPA 8015D Modified	0.032	0.095
n-Heptadecane	EPA 8015D Modified	0.018	0.033
n-Heptatriacontane	EPA 8015D Modified	0.011	0.033
n-Hexacosane	EPA 8015D Modified	0.019	0.033
n-Hexadecane	EPA 8015D Modified	0.011	0.033
n-Hexatriacontane	EPA 8015D Modified	0.011	0.033
n-Nonacosane	EPA 8015D Modified	0.011	0.033
n-Nonadecane	EPA 8015D Modified	0.016	0.033
n-Nonane	EPA 8015D Modified	0.011	0.033
n-Nonatriacontane	EPA 8015D Modified	0.02	0.06
n-Octacosane	EPA 8015D Modified	0.011	0.033
n-Octadecane	EPA 8015D Modified	0.015	0.033
n-Octatriacontane	EPA 8015D Modified	0.015	0.033
Norpristane(1650)	EPA 8015D Modified	0.011	0.033
n-Pentacosane	EPA 8015D Modified	0.011	0.033
n-Pentadecane	EPA 8015D Modified	0.011	0.033
n-Pentatriacontane	EPA 8015D Modified	0.011	0.033
n-Tetracontane	EPA 8015D Modified	0.011	0.033
n-Tetracosane	EPA 8015D Modified	0.011	0.033
n-Tetradecane	EPA 8015D Modified	0.014	0.033
n-Tetratriacontane	EPA 8015D Modified	0.013	0.033
n-Triacontane	EPA 8015D Modified	0.0202	0.0606
n-Tricosane	EPA 8015D Modified	0.014	0.033
n-Tridecane	EPA 8015D Modified	0.011	0.033
n-Tritriacontane	EPA 8015D Modified	0.022	0.033
n-Undecane	EPA 8015D Modified	0.0202	0.0607
Phytane	EPA 8015D Modified	0.011	0.033
Pristane	EPA 8015D Modified	0.017	0.033
DRO (C10-C28)	EPA 8015D Modified	4	12.0
Total Resolved SHC (C9-C40)	EPA 8015D Modified	4	12.0

Table B-4f

Biogas Generation Potential Analytes, Methods, and Targeted Reporting Limits

Parameter	Recommended Analytical Method	MDL[1]	MRL[1]
Total SHC	EPA 8015D Modified	0.011	0.033
TPH(C9-C44)	EPA 8015D Modified	4	12.0

Notes:
1. Actual MDLs and QLs may vary based on sample aliquot size, moisture content, and required dilution factor.

—: not applicable
ASTM: ASTM International
MDL: method detection limit
mg/kg: milligrams per kilogram
MRL: method reporting limit
SM: Standard Method
Modifications to method 8270D-SIM are:
- The continuing calibration verification %D for each calibrated PAH must be below 25%, with no more than 10% of all compounds greater than 25% but less than 35%. Each CCV must be analyzed within 24 hours of the previous CCV.
- The surrogate recovery limits are 50%-130%.
- The duplicate RPD limit is 30%.
- The PFTBA tuning is done once before each initial calibration.
- The internal standard compounds used for this method are acenaphthene-d10 and chrysene-d12.
- The confirmation ions listed in Alpha's SOP Table II are recommended and may be included or excluded based on project requirements.

Modifications to method 8015D are:
- The continuing calibration verification %D for each calibrated compound must be below 25%, with no more than 10% of all compounds greater than 25% but less than 35%. Each CCV must be analyzed within 24 hours of the previous CCV.
- Matrix spike and duplicate samples are analyzed only if requested by the client.

Modifications to the methods were made because of the extended analyte lists and analysis times.

Table B-4g

Extracted Subsurface Nonaqueous Phase Liquid Samples Analytes, Methods, and Targeted Reporting Limits

Parameter	Recommended Analytical Method	MDL[1]	MRL[1]
Petroleum Hydrocarbons (mg/kg)			
Total TPH(C9-C44)	EPA 8015D Modified	4	12.0

Notes:

1. Actual MDLs and QLs may vary based on sample aliquot size, moisture content, and required dilution factor.

EPA: U.S. Environmental Protection Agency

MDL: method detection limit

mg/kg: milligrams per kilogram

MRL: method reporting limit

Modifications to method 8015D are:

- The continuing calibration verification %D for each calibrated compound must be below 25%, with no more than 10% of all compounds greater than 25% but less than 35%. Each CCV must be analyzed within 24 hours of the previous CCV.
- Matrix spike and duplicate samples are analyzed only if requested by the client.

Modifications to the methods were made because of the extended analyte lists and analysis times.

Table B-4h
Additional Extended PAH Analyses Analytes, Methods, and Targeted Reporting Limits

Parameter	Recommended Analytical Method	MDL[1]	MRL[1]
Conventionals (%)			
Total Solids	SM 2540 G	0.10	0.10
PAHs and Alkylated PAHs (µg/kg)			
Acenaphthene	EPA 8270D SIM Modified	1.33	2.67
Acenaphthylene	EPA 8270D SIM Modified	1.33	2.67
Anthracene	EPA 8270D SIM Modified	1.33	2.67
Benzo(a)anthracene	EPA 8270D SIM Modified	1.33	2.67
Benzo(a)pyrene	EPA 8270D SIM Modified	2.00	4.00
Benzo(a)fluoranthene	EPA 8270D SIM Modified	0.20	1.01
Benzo(b)fluoranthene	EPA 8270D SIM Modified	2.00	4.00
Benzo(g,h,i)perylene	EPA 8270D SIM Modified	1.33	2.67
Benzo(j)+(k)Fluoranthene	EPA 8270D SIM Modified	2.00	4.00
Chrysene	EPA 8270D SIM Modified	1.33	2.67
Dibenz(a,h)+(a,c)anthracene	EPA 8270D SIM Modified	1.33	2.67
Fluoranthene	EPA 8270D SIM Modified	1.33	2.67
Fluorene	EPA 8270D SIM Modified	1.33	2.67
Indeno(1,2,3-c,d)pyrene	EPA 8270D SIM Modified	1.33	2.67
Naphthalene	EPA 8270D SIM Modified	2.67	5.33
Phenanthrene	EPA 8270D SIM Modified	1.33	2.67
Pyrene	EPA 8270D SIM Modified	1.33	2.67
Cis/Trans-Decalin	EPA 8270D SIM Modified	0.252	0.50
C1-Decalins	EPA 8270D SIM Modified	0.252	1.01
C2-Decalins	EPA 8270D SIM Modified	0.252	1.01
C3-Decalins	EPA 8270D SIM Modified	0.252	1.01
C4-Decalins	EPA 8270D SIM Modified	0.252	1.01
C1-Naphthalenes	EPA 8270D SIM Modified	0.289	1.01
C2-Naphthalenes	EPA 8270D SIM Modified	0.289	1.01
C3-Naphthalenes	EPA 8270D SIM Modified	0.289	1.01
C4-Naphthalenes	EPA 8270D SIM Modified	0.289	1.01
2-Methylnaphthalene	EPA 8270D SIM Modified	0.259	1.01
1-Methylnaphthalene	EPA 8270D SIM Modified	0.317	1.01
Benzothiophene	EPA 8270D SIM Modified	0.315	1.01
C1-Benzo(b)thiophenes	EPA 8270D SIM Modified	0.315	1.01
C2-Benzo(b)thiophenes	EPA 8270D SIM Modified	0.315	1.01
C3-Benzo(b)thiophenes	EPA 8270D SIM Modified	0.315	1.01
C4-Benzo(b)thiophenes	EPA 8270D SIM Modified	0.315	1.01
Biphenyl	EPA 8270D SIM Modified	0.311	1.01
2,6-Dimethylnaphthalene	EPA 8270D SIM Modified	0.239	1.01
Dibenzofuran	EPA 8270D SIM Modified	0.317	1.01
2,3,5-Trimethylnaphthalene	EPA 8270D SIM Modified	0.164	1.01
C1-Fluorenes	EPA 8270D SIM Modified	0.268	1.01
C2-Fluorenes	EPA 8270D SIM Modified	0.268	1.01

Table B-4h

Additional Extended PAH Analyses Analytes, Methods, and Targeted Reporting Limits

Parameter	Recommended Analytical Method	MDL[1]	MRL[1]
C3-Fluorenes	EPA 8270D SIM Modified	0.268	1.01
Dibenzothiophene	EPA 8270D SIM Modified	0.277	1.01
4-Methyldibenzothiophene(4MDT)	EPA 8270D SIM Modified	0.277	1.01
2/3-Methyldibenzothiophene(2MDT)	EPA 8270D SIM Modified	0.277	1.01
1-Methyldibenzothiophene(1MDT)	EPA 8270D SIM Modified	0.277	1.01
C1-Dibenzothiophenes	EPA 8270D SIM Modified	0.277	1.01
C2-Dibenzothiophenes	EPA 8270D SIM Modified	0.277	1.01
C3-Dibenzothiophenes	EPA 8270D SIM Modified	0.277	1.01
C4-Dibenzothiophenes	EPA 8270D SIM Modified	0.277	1.01
3-Methylphenanthrene (3MP)	EPA 8270D SIM Modified	0.333	1.01
2-Methylphenanthrene (2MP)	EPA 8270D SIM Modified	0.333	1.01
2-Methylanthracene (2MA)	EPA 8270D SIM Modified	0.333	1.01
9/4-Methylphenanthrene (9MP)	EPA 8270D SIM Modified	0.333	1.01
1-Methylphenanthrene (1MP)	EPA 8270D SIM Modified	0.333	1.01
C1-Phenanthrenes/Anthracenes	EPA 8270D SIM Modified	0.333	1.01
C2-Phenanthrenes/Anthracenes	EPA 8270D SIM Modified	0.333	1.01
C3-Phenanthrenes/Anthracenes	EPA 8270D SIM Modified	0.333	1.01
C4-Phenanthrenes/Anthracenes	EPA 8270D SIM Modified	0.333	1.01
Retene	EPA 8270D SIM Modified	0.247	1.01
Carbazole	EPA 8270D SIM Modified	0.329	1.01
Benzo(b)fluorene	EPA 8270D SIM Modified	0.291	1.01
7H-Benzo(c)fluorene	EPA 8270D SIM Modified	0.291	1.01
2-Methylpyrene	EPA 8270D SIM Modified	0.264	1.01
4-Methylpyrene	EPA 8270D SIM Modified	0.264	1.01
1-Methylpyrene	EPA 8270D SIM Modified	0.264	1.01
C1-Fluoranthenes/Pyrenes	EPA 8270D SIM Modified	0.264	1.01
C2-Fluoranthenes/Pyrenes	EPA 8270D SIM Modified	0.264	1.01
C3-Fluoranthenes/Pyrenes	EPA 8270D SIM Modified	0.264	1.01
C4-Fluoranthenes/Pyrenes	EPA 8270D SIM Modified	0.264	1.01
Naphthobenzothiophene	EPA 8270D SIM Modified	0.281	1.01
C1-Naphthobenzothiophenes	EPA 8270D SIM Modified	0.281	1.01
C2-Naphthobenzothiophenes	EPA 8270D SIM Modified	0.281	1.01
C3-Naphthobenzothiophenes	EPA 8270D SIM Modified	0.281	1.01
C4-Naphthobenzothiophenes	EPA 8270D SIM Modified	0.281	1.01
C1-Chrysenes	EPA 8270D SIM Modified	0.203	1.01
C2-Chrysenes	EPA 8270D SIM Modified	0.203	1.01
C3-Chrysenes	EPA 8270D SIM Modified	0.203	1.01
C4-Chrysenes	EPA 8270D SIM Modified	0.203	1.01
Benzo(e)pyrene	EPA 8270D SIM Modified	0.207	1.01
Perylene	EPA 8270D SIM Modified	0.194	1.01

Table B-4h
Additional Extended PAH Analyses Analytes, Methods, and Targeted Reporting Limits

Parameter	Recommended Analytical Method	MDL[1]	MRL[1]
Petroleum Biomarkers (µg/kg)			
Hopane (T19)	EPA 8270D SIM Modified	0.286	1.005
C23 Tricyclic Terpane (T4)	EPA 8270D SIM Modified	0.286	1.005
C24 Tricyclic Terpane (T5)	EPA 8270D SIM Modified	0.286	1.005
C25 Tricyclic Terpane (T6)	EPA 8270D SIM Modified	0.286	1.005
C24 Tetracyclic Terpane (T6a)	EPA 8270D SIM Modified	0.286	1.005
C26 Tricyclic Terpane-22S (T6b)	EPA 8270D SIM Modified	0.286	1.005
C26 Tricyclic Terpane-22R (T6c)	EPA 8270D SIM Modified	0.286	1.005
C28 Tricyclic Terpane-22S (T7)	EPA 8270D SIM Modified	0.286	1.005
C28 Tricyclic Terpane-22R (T8)	EPA 8270D SIM Modified	0.286	1.005
C29 Tricyclic Terpane-22S (T9)	EPA 8270D SIM Modified	0.286	1.005
C29 Tricyclic Terpane-22R (T10)	EPA 8270D SIM Modified	0.286	1.005
18a-22,29,30-Trisnorneohopane-TS (T11)	EPA 8270D SIM Modified	0.286	1.005
C30 Tricyclic Terpane-22S	EPA 8270D SIM Modified	0.286	1.005
C30 Tricyclic Terpane-22R	EPA 8270D SIM Modified	0.286	1.005
17a(H)-22,29,30-Trisnorhopane-TM (T12)	EPA 8270D SIM Modified	0.286	1.005
17a/b,21b/a 28,30-Bisnorhopane (T14a)	EPA 8270D SIM Modified	0.286	1.005
17a(H),21b(H)-25-Norhopane (T14b)	EPA 8270D SIM Modified	0.286	1.005
30-Norhopane (T15)	EPA 8270D SIM Modified	0.286	1.005
18a(H)-30-Norneohopane-C29Ts (T16)	EPA 8270D SIM Modified	0.286	1.005
17a(H)-Diahopane (X)	EPA 8270D SIM Modified	0.286	1.005
30-Normoretane (T17)	EPA 8270D SIM Modified	0.286	1.005
18a(H)&18b(H)-Oleananes (T18)	EPA 8270D SIM Modified	0.286	1.005
Moretane (T20)	EPA 8270D SIM Modified	0.286	1.005
30-Homohopane-22S (T21)	EPA 8270D SIM Modified	0.286	1.005
30-Homohopane-22R (T22)	EPA 8270D SIM Modified	0.286	1.005
Gammacerane/C32-Diahopane	EPA 8270D SIM Modified	0.286	1.005
30,31-Bishomohopane-22S (T26)	EPA 8270D SIM Modified	0.286	1.005
30,31-Bishomohopane-22R (T27)	EPA 8270D SIM Modified	0.286	1.005
30,31-Trishomohopane-22S (T30)	EPA 8270D SIM Modified	0.286	1.005
30,31-Trishomohopane-22R (T31)	EPA 8270D SIM Modified	0.286	1.005
Tetrakishomohopane-22S (T32)	EPA 8270D SIM Modified	0.286	1.005
Tetrakishomohopane-22R (T33)	EPA 8270D SIM Modified	0.286	1.005
Pentakishomohopane-22S (T34)	EPA 8270D SIM Modified	0.286	1.005
Pentakishomohopane-22R (T35)	EPA 8270D SIM Modified	0.286	1.005
13b(H),17a(H)-20S-Diacholestane (S4)	EPA 8270D SIM Modified	0.223	1.005
13b(H),17a(H)-20R-Diacholestane (S5)	EPA 8270D SIM Modified	0.223	1.005
13b,17a-20S-Methyldiacholestane (S8)	EPA 8270D SIM Modified	0.223	1.005
17a(H)20SC27/C29dia	EPA 8270D SIM Modified	0.223	1.005
17a(H)20rc27/C29dia	EPA 8270D SIM Modified	0.223	1.005
Unknown Sterane (S18)	EPA 8270D SIM Modified	0.223	1.005
13a,17b-20S-Ethyldiacholestane (S19)	EPA 8270D SIM Modified	0.223	1.005

Table B-4h
Additional Extended PAH Analyses Analytes, Methods, and Targeted Reporting Limits

Parameter	Recommended Analytical Method	MDL[1]	MRL[1]
14a,17a-20S-Methylcholestane (S20)	EPA 8270D SIM Modified	0.223	1.005
14a,17a-20R-Methylcholestane (S24)	EPA 8270D SIM Modified	0.223	1.005
14a(H),17a(H)-20S-Ethylcholestane (S25)	EPA 8270D SIM Modified	0.223	1.005
14a(H),17a(H)-20R-Ethylcholestane (S28)	EPA 8270D SIM Modified	0.223	1.005
14b(H),17b(H)-20R-Cholestane (S14)	EPA 8270D SIM Modified	0.223	1.005
14b(H),17b(H)-20S-Cholestane (S15)	EPA 8270D SIM Modified	0.223	1.005
14b,17b-20R-Methylcholestane (S22)	EPA 8270D SIM Modified	0.223	1.005
14B,17B-20S-METHYLCHOLESTANE (S23)	EPA 8270D SIM Modified	0.223	1.005
14b(H),17b(H)-20R-Ethylcholestane (S26)	EPA 8270D SIM Modified	0.223	1.005
14b(H),17b(H)-20S-Ethylcholestane (S27)	EPA 8270D SIM Modified	0.223	1.005
C26,20R+C27,20S TAS	EPA 8270D SIM Modified	0.223	1.005
C28,20S TAS	EPA 8270D SIM Modified	0.223	1.005
C27,20R TAS	EPA 8270D SIM Modified	0.223	1.005
C28,20R TAS	EPA 8270D SIM Modified	0.223	1.005
Saturated Hydrocarbons (mg/kg)			
Isoprenoid RRT 1380	EPA 8015D Modified	0.011	0.033
Isoprenoid RRT 1470	EPA 8015D Modified	0.011	0.033
n-Decane	EPA 8015D Modified	0.0148	0.0445
n-Docosane	EPA 8015D Modified	0.011	0.033
n-Dodecane	EPA 8015D Modified	0.011	0.033
n-Dotriacontane	EPA 8015D Modified	0.013	0.033
n-Eicosane	EPA 8015D Modified	0.012	0.033
n-Heneicosane	EPA 8015D Modified	0.011	0.033
n-Hentriacontane	EPA 8015D Modified	0.0162	0.0486
n-Heptacosane	EPA 8015D Modified	0.032	0.095
n-Heptadecane	EPA 8015D Modified	0.018	0.033
n-Heptatriacontane	EPA 8015D Modified	0.011	0.033
n-Hexacosane	EPA 8015D Modified	0.019	0.033
n-Hexadecane	EPA 8015D Modified	0.011	0.033
n-Hexatriacontane	EPA 8015D Modified	0.011	0.033
n-Nonacosane	EPA 8015D Modified	0.011	0.033
n-Nonadecane	EPA 8015D Modified	0.016	0.033
n-Nonane	EPA 8015D Modified	0.011	0.033
n-Nonatriacontane	EPA 8015D Modified	0.02	0.06
n-Octacosane	EPA 8015D Modified	0.011	0.033
n-Octadecane	EPA 8015D Modified	0.015	0.033
n-Octatriacontane	EPA 8015D Modified	0.015	0.033
Norpristane(1650)	EPA 8015D Modified	0.011	0.033
n-Pentacosane	EPA 8015D Modified	0.011	0.033
n-Pentadecane	EPA 8015D Modified	0.011	0.033
n-Pentatriacontane	EPA 8015D Modified	0.011	0.033
n-Tetracontane	EPA 8015D Modified	0.011	0.033

Table B-4h
Additional Extended PAH Analyses Analytes, Methods, and Targeted Reporting Limits

Parameter	Recommended Analytical Method	MDL[1]	MRL[1]
n-Tetracosane	EPA 8015D Modified	0.011	0.033
n-Tetradecane	EPA 8015D Modified	0.014	0.033
n-Tetratriacontane	EPA 8015D Modified	0.013	0.033
n-Triacontane	EPA 8015D Modified	0.0202	0.0606
n-Tricosane	EPA 8015D Modified	0.014	0.033
n-Tridecane	EPA 8015D Modified	0.011	0.033
n-Tritriacontane	EPA 8015D Modified	0.022	0.033
n-Undecane	EPA 8015D Modified	0.0202	0.0607
Phytane	EPA 8015D Modified	0.011	0.033
Pristane	EPA 8015D Modified	0.017	0.033
DRO (C10-C28)	EPA 8015D Modified	4	12.0
Total Resolved SHC (C9-C40)	EPA 8015D Modified	4	12.0
Total SHC	EPA 8015D Modified	0.011	0.033
TPH(C9-C44)	EPA 8015D Modified	4	12.0

Notes:
1. Actual MDLs and QLs may vary based on sample aliquot size, moisture content, and required dilution factor.
µg/kg: micrograms per kilogram
EPA: U.S. Environmental Protection Agency
MDL: method detection limit
mg/kg: milligrams per kilogram
MRL: method reporting limit
SIM: select ion monitoring
SM: Standard Method
Modifications to method 8270D-SIM are:
- The continuing calibration verification %D for each calibrated PAH must be below 25%, with no more than 10% of all compounds greater than 25% but less than 35%. Each CCV must be analyzed within 24 hours of the previous CCV.
- The surrogate recovery limits are 50%-130%.
- The duplicate RPD limit is 30%.
- The PFTBA tuning is done once before each initial calibration.
- The internal standard compounds used for this method are acenaphthene-d10 and chrysene-d12.
- The confirmation ions listed in Alpha's SOP Table II are recommended and may be included or excluded based on project requirements.

Modifications to method 8015D are:
- The continuing calibration verification %D for each calibrated compound must be below 25%, with no more than 10% of all compounds greater than 25% but less than 35%. Each CCV must be analyzed within 24 hours of the previous CCV.
- Matrix spike and duplicate samples are analyzed only if requested by the client.

Modifications to the methods were made because of the extended analyte lists and analysis times.

Table B-4i
Additional Non PAH Analyses Analytes, Methods, and Targeted Reporting Limits

Parameter	Recommended Analytical Method	Site-Wide RALs[1]	PTW Thresholds[1]	Navigation Channel RALs[1]	MDL[2]	MRL[2]
PCB Aroclors (µg/kg)						
Aroclor 1016	EPA 8082A	—	—	—	0.67	1.33
Aroclor 1221	EPA 8082A	—	—	—	0.67	1.33
Aroclor 1232	EPA 8082A	—	—	—	0.67	1.33
Aroclor 1242	EPA 8082A	—	—	—	0.67	1.33
Aroclor 1248	EPA 8082A	—	—	—	0.67	1.33
Aroclor 1254	EPA 8082A	—	—	—	0.67	1.33
Aroclor 1260	EPA 8082A	—	—	—	0.67	1.33
Aroclor 1262	EPA 8082A	—	—	—	0.67	1.33
Aroclor 1268	EPA 8082A	—	—	—	0.67	1.33
Total PCB Aroclors[3,4]	—	75	200	1,000	—	—
Dioxin/Furans (ng/kg)						
2,3,7,8-TCDD	EPA 1613B	6	10	2	0.28	0.5
1,2,3,7,8-PeCDD	EPA 1613B	8	—	—	0.59	2.5
1,2,3,4,7,8-HxCDD	EPA 1613B	—	—	—	0.60	2.5
1,2,3,6,7,8-HxCDD	EPA 1613B	—	—	—	0.38	2.5
1,2,3,7,8,9-HxCDD	EPA 1613B	—	—	—	0.57	2.5
1,2,3,4,6,7,8-HpCDD	EPA 1613B	—	—	—	0.54	2.5
OCDD	EPA 1613B	—	—	—	1.58	5.0
2,3,7,8-TCDF	EPA 1613B	—	600	—	0.31	0.5
1,2,3,7,8-PeCDF	EPA 1613B	—	—	—	0.49	2.5
2,3,4,7,8-PeCDF	EPA 1613B	200	200	1,000	0.30	2.5
1,2,3,4,7,8-HxCDF	EPA 1613B	—	40	—	0.65	2.5
1,2,3,6,7,8-HxCDF	EPA 1613B	—	—	—	0.89	2.5
1,2,3,7,8,9-HxCDF	EPA 1613B	—	—	—	0.63	2.5
2,3,4,6,7,8-HxCDF	EPA 1613B	—	—	—	0.78	2.5
1,2,3,4,6,7,8-HpCDF	EPA 1613B	—	—	—	0.43	2.5
1,2,3,4,7,8,9-HpCDF	EPA 1613B	—	—	—	0.65	2.5
OCDF	EPA 1613B	—	—	—	0.83	5.0
2,3,7,8-TCDD eq (2005 WHO TEQ)[3,4]	—	—	—	—	—	—
Low Resolution Pesticides (µg/kg)						
2,4'-DDD	EPA 8081B	—	—	—	0.50	1.00
2,4'-DDE	EPA 8081B	—	—	—	0.50	1.00
2,4'-DDT	EPA 8081B	—	—	—	0.50	1.00
4,4'-DDD	EPA 8081B	—	—	—	0.50	1.00
4,4'-DDE	EPA 8081B	—	—	—	0.50	1.00
4,4'-DDT	EPA 8081B	—	—	—	0.50	1.00
DDx[4]	—	160	7,050	650	—	—

Table B-4i
Additional Non PAH Analyses Analytes, Methods, and Targeted Reporting Limits

Notes:

1. The Sediment RALs and PTW Threshold Values are presented in Table 21 of the *Record of Decision – Portland Harbor Superfund Site* (ROD; EPA 2017).
2. Actual MDLs and QLs may vary based on sample aliquot size, moisture content, and required dilution factor.
3. The naphthalene threshold value was developed for the ROD based on feasibility-level harborwide assumptions that are not applicable at the site. NW Natural is performing a site-specific capping demonstration evaluation to determine if any of the ROD Table 17 COCs containing groundwater cleanup levels cannot be reliably contained.
4. cPAH (BaP eq), total PAHs, total PCBs, 2,3,7,8-TCDD eq, and DDx are calculated values; therefore, there are no MDLs or MRLs for these parameters.
5. Total cPAH is the sum of benzo(a)pyrene equivalent concentrations, calculated by multiplying the cPAHs by their respective potency factors. cPAHs include benzo(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, indeno(1,2,3-c,d)pyrene, and dibenzo(a,h)anthracene.
6. Total PAH is the sum of 2-methylnaphthalene, acenapthene, acenaphthylene, anthracene, fluorene, naphthalene, phenanthrene, fluoranthene, pyrene, benzo(a)anthracene, chrysene, benzofluoranthenes, benzo(a)pyrene, indeno(1,2,3-c,d)pyrene, dibenzo(a,h)anthracene, and benzo(g,h,i)perylene.

—: not applicable
μg/kg: micrograms per kilogram
ASTM: ASTM International
BaP Eq: benzo(a)pyrene equivalent
cPAH: carcinogenic polycyclic aromatic hydrocarbon
EPA: U.S. Environmental Protection Agency
MDL: method detection limit
mg/kg: milligrams per kilogram
MRL: method reporting limit
ng/kg: nanograms per kilogram
PTW: principal threat waste
RAL: remedial action level
SM: Standard Method

Table B-5a
Sediment Samples to Develop Site-Specific Equilibrium Partitioning Coefficients Analytes, Methods, and Target Reporting Limits

Parameter	Recommended Analytical Method	MDL	MRL
Conventionals (%)			
Total Solids	SM 2540 G	0.10	0.10
Total Organic Carbon	SM 5310 B	0.10	0.20
Volatile Organic Compounds (µg/kg)			
1,1,1,2-Tetrachloroethane	EPA 8260C	13	25
1,1,1-Trichloroethane	EPA 8260C	13	25
1,1,2,2-Tetrachloroethane	EPA 8260C	25	50
1,1,2-Trichloro-1,2,2-trifluoroethane	EPA 8260C	50	100
1,1,2-Trichloroethane	EPA 8260C	13	25
1,1-Dichloroethane	EPA 8260C	13	25
1,1-Dichloroethene	EPA 8260C	13	25
1,1-Dichloroethene (1,1-DCE)	EPA 8260C	13	25
1,1-Dichloropropene	EPA 8260C	25	50
1,2,3-Trichlorobenzene	EPA 8260C	125	250
1,2,3-Trichloropropane	EPA 8260C	25	50
1,2,4-Trichlorobenzene	EPA 8260C	125	250
1,2,4-Trimethylbenzene	EPA 8260C	25	50
1,2-Dibromo-3-chloropropane	EPA 8260C	125	250
1,2-Dibromoethane	EPA 8260C	25	50
1,2-Dichlorobenzene	EPA 8260C	13	25
1,2-Dichloroethane	EPA 8260C	13	25
1,2-Dichloropropane	EPA 8260C	13	25
1,3,5-Trimethylbenzene	EPA 8260C	25	50
1,3-Dichlorobenzene	EPA 8260C	13	25
1,3-Dichloropropane	EPA 8260C	25	50
1,4-Dichlorobenzene	EPA 8260C	13	25
2,2-Dichloropropane	EPA 8260C	25	50
2-Butanone	EPA 8260C	250	500
2-Chlorotoluene	EPA 8260C	25	50
2-Hexanone	EPA 8260C	250	500
4-Chlorotoluene	EPA 8260C	25	50
4-Isopropyltoluene	EPA 8260C	25	50
4-Methyl-2-pentanone	EPA 8260C	250	500

Table B-5a

Sediment Samples to Develop Site-Specific Equilibrium Partitioning Coefficients Analytes, Methods, and Target Reporting Limits

Parameter	Recommended Analytical Method	MDL	MRL
Acetone	EPA 8260C	500	1000
Acrylonitrile	EPA 8260C	50	100
Benzene	EPA 8260C	5.0	10
Benzene	EPA 8260C	5.0	10
Bromobenzene	EPA 8260C	13	25
Bromochloromethane	EPA 8260C	25	50
Bromodichloromethane	EPA 8260C	25	50
Bromoform	EPA 8260C	50	100
Bromomethane	EPA 8260C	500	500
Carbon disulfide	EPA 8260C	250	500
Carbon tetrachloride	EPA 8260C	25	50
Chlorobenzene	EPA 8260C	13	25
Chlorobenzene	EPA 8260C	13	25
Chloroethane	EPA 8260C	250	500
Chloroform	EPA 8260C	25	50
Chloromethane	EPA 8260C	125	250
cis-1,2-Dichloroethene	EPA 8260C	13	25
cis-1,2-Dichloroethene (cis-DCE)	EPA 8260C	13	25
cis-1,3-Dichloropropene	EPA 8260C	25	50
Dibromochloromethane	EPA 8260C	50	100
Dibromomethane	EPA 8260C	25	50
Dichlorodifluoromethane	EPA 8260C	50	100
Ethylbenzene	EPA 8260C	13	25
Ethylbenzene	EPA 8260C	13	25
Hexachlorobutadiene	EPA 8260C	50	100
Isopropylbenzene	EPA 8260C	25	50
m,p-Xylene	EPA 8260C	25	50
m,p-Xylene	EPA 8260C	25	50
Methyl tert-butyl ether (MTBE)	EPA 8260C	25	50
Methylene chloride	EPA 8260C	125	250
Naphthalene	EPA 8260C	50	100
n-Butylbenzene	EPA 8260C	25	50
n-Hexane	EPA 8260C	250	500
n-Propylbenzene	EPA 8260C	13	25
o-Xylene	EPA 8260C	13	25
sec-Butylbenzene	EPA 8260C	25	50

Table B-5a

Sediment Samples to Develop Site-Specific Equilibrium Partitioning Coefficients Analytes, Methods, and Target Reporting Limits

Parameter	Recommended Analytical Method	MDL	MRL
Styrene	EPA 8260C	25	50
tert-Butylbenzene	EPA 8260C	25	50
Tetrachloroethene	EPA 8260C	13	25
Tetrachloroethene	EPA 8260C	13	25
Toluene	EPA 8260C	13	25
Toluene	EPA 8260C	25	50
Total Xylenes	—	38	75
trans-1,2-Dichloroethene	EPA 8260C	13	25
trans-1,3-Dichloropropene	EPA 8260C	25	50
trans-1,4-Dichloro-2-butene	EPA 8260C	250	500
Trichloroethene	EPA 8260C	13	25
Trichloroethene (TCE)	EPA 8260C	13	25
Trichlorofluoromethane	EPA 8260C	50	100
Vinyl Chloride	EPA 8260C	13	25
Vinyl chloride	EPA 8260C	13	25
Xylenes, total	EPA 8260C	38	75

Notes:

μg/L: micrograms per liter

—: not applicable

EPA: U.S. Environmental Protection Agency

MDL: method detection limit

MRL: method reporting limit

Table B-5b
Porewater Samples to Develop Site-Specific Equilibrium Partitioning Coefficients Analytes, Methods, and Target Reporting Limits

Parameter	Recommended Analytical Method	Groundwater Cleanup Levels[1]	MDL	MRL
Conventionals (mg/L)				
Total Suspended Solids	SM 2540 D	—	5.0	5.0
Total Organic Carbon	SM 5310 C	—	1.0	1.0
Dissolved Organic Carbon	SM 5310 C	—	1.0	1.0
Volatile Organic Compounds (µg/L)				
Acetone	EPA 8260C	—	10.0	20.0
Acrylonitrile	EPA 8260C	—	1	2
Benzene	EPA 8260C	0.44	0.1	0.2
Bromobenzene	EPA 8260C	—	0.25	0.5
Bromochloromethane	EPA 8260C	—	0.5	1
Bromodichloromethane	EPA 8260C	—	0.5	1
Bromoform	EPA 8260C	—	0.5	1
Bromomethane	EPA 8260C	—	5	5
2-Butanone (MEK)	EPA 8260C	—	5	10.0
n-Butylbenzene	EPA 8260C	—	0.5	1.0
sec-Butylbenzene	EPA 8260C	—	0.5	1.0
tert-Butylbenzene	EPA 8260C	—	0.5	1.0
Carbon disulfide	EPA 8260C	—	5	10.0
Carbon tetrachloride	EPA 8260C	—	0.5	1.0
Chlorobenzene	EPA 8260C	64	0.25	0.5
Chloroethane	EPA 8260C	—	5.0	5.0
Chloroform	EPA 8260C	—	0.5	1.0
Chloromethane	EPA 8260C	—	2.5	5.0
2-Chlorotoluene	EPA 8260C	—	0.5	1.0
4-Chlorotoluene	EPA 8260C	—	0.5	1.0
Dibromochloromethane	EPA 8260C	—	0.5	1.0
1,2-Dibromo-3-chloropropane	EPA 8260C	—	2.5	5.0
1,2-Dibromoethane (EDB)	EPA 8260C	—	0.25	0.5
Dibromomethane	EPA 8260C	—	0.5	1.0

Table B-5b

Porewater Samples to Develop Site-Specific Equilibrium Partitioning Coefficients Analytes, Methods, and Target Reporting Limits

Parameter	Recommended Analytical Method	Groundwater Cleanup Levels[1]	MDL	MRL
1,2-Dichlorobenzene	EPA 8260C	—	0.25	0.5
1,3-Dichlorobenzene	EPA 8260C	—	0.25	0.5
1,4-Dichlorobenzene	EPA 8260C	—	0.25	0.5
Dichlorodifluoromethane	EPA 8260C	—	0.5	1.0
1,1-Dichloroethane	EPA 8260C	—	0.2	0.4
1,2-Dichloroethane (EDC)	EPA 8260C	—	0.2	0.4
1,1-Dichloroethene	EPA 8260C	7	0.2	0.4
cis-1,2-Dichloroethene	EPA 8260C	9.9	0.2	0.4
trans-1,2-Dichloroethene	EPA 8260C	—	0.2	0.4
1,2-Dichloropropane	EPA 8260C	—	0.25	0.5
1,3-Dichloropropane	EPA 8260C	—	0.5	1.0
2,2-Dichloropropane	EPA 8260C	—	0.5	1.0
1,1-Dichloropropene	EPA 8260C	—	0.5	1.0
cis-1,3-Dichloropropene	EPA 8260C	—	0.5	1.0
trans-1,3-Dichloropropene	EPA 8260C	—	0.5	1.0
Ethylbenzene	EPA 8260C	7.3	0.250	0.5
Hexachlorobutadiene	EPA 8260C	—	2.5	5.0
n-Hexane	EPA 8260C	—	5.0	10.0
2-Hexanone	EPA 8260C	—	5.0	10.0
Isopropylbenzene	EPA 8260C	—	0.5	1.0
4-Isopropyltoluene	EPA 8260C	—	0.5	1.0
Methylene chloride	EPA 8260C	—	1.5	3.0
4-Methyl-2-pentanone (MiBK)	EPA 8260C	—	5.0	10.0
Methyl tert-butyl ether (MTBE)	EPA 8260C	—	0.5	1.0
Naphthalene	EPA 8260C	—	1.0	2.0
n-Propylbenzene	EPA 8260C	—	0.25	0.5
Styrene	EPA 8260C	—	0.5	1.0
1,1,1,2-Tetrachloroethane	EPA 8260C	—	0.2	0.4
1,1,2,2-Tetrachloroethane	EPA 8260C	—	0.25	0.5

Table B-5b

Porewater Samples to Develop Site-Specific Equilibrium Partitioning Coefficients Analytes, Methods, and Target Reporting Limits

Parameter	Recommended Analytical Method	Groundwater Cleanup Levels[1]	MDL	MRL
Tetrachloroethene (PCE)	EPA 8260C	0.24	0.2	0.4
Tetrahydrofuran	EPA 8260C	—	5.0	10.0
Toluene	EPA 8260C	9.8	0.5	1.0
1,2,3-Trichlorobenzene	EPA 8260C	—	1.0	2.0
1,2,4-Trichlorobenzene	EPA 8260C	—	1.0	2.0
1,1,1-Trichloroethane	EPA 8260C	—	0.2	0.4
1,1,2-Trichloroethane	EPA 8260C	—	0.25	0.5
Trichloroethene (TCE)	EPA 8260C	0.6	0.2	0.4
Trichlorofluoromethane	EPA 8260C	—	1.0	2.0
1,2,3-Trichloropropane	EPA 8260C	—	0.5	1.0
1,1,2-Trichloro-1,2,2-trifluoroethane (Freon-113)	EPA 8260C	—	1.0	2.0
1,2,4-Trimethylbenzene	EPA 8260C	—	0.5	1.0
1,3,5-Trimethylbenzene	EPA 8260C	—	0.5	1.0
Isobutyl alcohol	EPA 8260C	—	250	250
Vinyl chloride	EPA 8260C-SIM	0.022	0.2	0.4
m,p-Xylene	EPA 8260C	—	0.5	1.0
o-Xylene	EPA 8260C	—	0.25	0.5
trans-1,4-Dichloro-2-butene	EPA 8260C	—	5.0	10.0
Total xylenes	EPA 8260C	13	0.75	1.5

Notes:

1. The Groundwater Cleanup Levels are presented in Table 17 of the *Record of Decision – Portland Harbor Superfund Site* (EPA 2017).

µg/L: micrograms per liter

—: not applicable

EPA: U.S. Environmental Protection Agency

MDL: method detection limit

MRL: method reporting limit

Table B-5c

Porewater Samples in Contact with PTW-NAPL Sediments Analytes, Methods, and Targeted Reporting Limits

Parameter	Recommended Analytical Method	Groundwater Cleanup Levels[1]	MDL	MRL
Conventionals (mg/L)				
Total Suspended Solids	SM 2540 D	—	5.0	5.0
Total Organic Carbon	SM 5310 C	—	1.0	1.0
Dissolved Organic Carbon	SM 5310 C	—	1.0	1.0
Polycyclic Aromatic Hydrocarbons (µg/L)[2]				
2-Methylnaphthalene	EPA 8270D	—	0.5	1.0
Acenaphthene	EPA 8270D	—	0.5	1.0
Acenaphthylene	EPA 8270D	—	0.5	1.0
Anthracene	EPA 8270D	0.73	0.5	1.0
Benzo(a)anthracene	EPA 8270D	0.0012	0.5	1.0
Benzo(a)pyrene	EPA 8270D	0.00012	0.5	1.0
Benzo(b)fluoranthene	EPA 8270D	0.0012	0.5	1.0
Benzo(g,h,i)perylene	EPA 8270D	—	0.5	1.0
Benzo(k)fluoranthene	EPA 8270D	0.0013	0.5	1.0
Chrysene	EPA 8270D	0.0013	0.5	1.0
Dibenz(a,h)anthracene	EPA 8270D	0.00012	0.5	1.0
Fluoranthene	EPA 8270D	—	0.5	1.0
Fluorene	EPA 8270D	—	0.5	1.0
Indeno(1,2,3-c,d)pyrene	EPA 8270D	0.0012	0.5	1.0
Naphthalene	EPA 8270D	—	0.5	1.0
Phenanthrene	EPA 8270D	—	0.5	1.0
Pyrene	EPA 8270D	—	0.5	1.0
cPAHs (BaP eq)[3]	—	0.00012	—	—
Volatile Organic Compounds (µg/L)				
Acetone	EPA 8260C	—	10.0	20.0
Acrylonitrile	EPA 8260C	—	1.0	2.0
Benzene	EPA 8260C	0.44	0.1	0.2
Bromobenzene	EPA 8260C	—	0.25	0.5
Bromochloromethane	EPA 8260C	—	0.5	1.0

Table B-5c
Porewater Samples in Contact with PTW-NAPL Sediments Analytes, Methods, and Targeted Reporting Limits

Parameter	Recommended Analytical Method	Groundwater Cleanup Levels[1]	MDL	MRL
Bromodichloromethane	EPA 8260C	—	0.5	1.0
Bromoform	EPA 8260C	—	0.5	1.0
Bromomethane	EPA 8260C	—	5.0	5.0
2-Butanone (MEK)	EPA 8260C	—	5.0	10
n-Butylbenzene	EPA 8260C	—	0.5	1.0
sec-Butylbenzene	EPA 8260C	—	0.5	1.0
tert-Butylbenzene	EPA 8260C	—	0.5	1.0
Carbon disulfide	EPA 8260C	—	5.0	10
Carbon tetrachloride	EPA 8260C	—	0.5	1.0
Chlorobenzene	EPA 8260C	64	0.25	0.5
Chloroethane	EPA 8260C	—	5.0	5.0
Chloroform	EPA 8260C	—	0.5	1.0
Chloromethane	EPA 8260C	—	2.5	5.0
2-Chlorotoluene	EPA 8260C	—	0.5	1.0
4-Chlorotoluene	EPA 8260C	—	0.5	1.0
Dibromochloromethane	EPA 8260C	—	0.5	1.0
1,2-Dibromo-3-chloropropane	EPA 8260C	—	2.5	5.0
1,2-Dibromoethane (EDB)	EPA 8260C	—	0.25	0.5
Dibromomethane	EPA 8260C	—	0.5	1.0
1,2-Dichlorobenzene	EPA 8260C	—	0.25	0.5
1,3-Dichlorobenzene	EPA 8260C	—	0.25	0.5
1,4-Dichlorobenzene	EPA 8260C	—	0.25	0.5
Dichlorodifluoromethane	EPA 8260C	—	0.5	1.0
1,1-Dichloroethane	EPA 8260C	—	0.2	0.4
1,2-Dichloroethane (EDC)	EPA 8260C	—	0.2	0.4
1,1-Dichloroethene	EPA 8260C	7	0.2	0.4
cis-1,2-Dichloroethene	EPA 8260C	9.9	0.2	0.4
trans-1,2-Dichloroethene	EPA 8260C	—	0.2	0.4
1,2-Dichloropropane	EPA 8260C	—	0.25	0.5

Table B-5c
Porewater Samples in Contact with PTW-NAPL Sediments Analytes, Methods, and Targeted Reporting Limits

Parameter	Recommended Analytical Method	Groundwater Cleanup Levels[1]	MDL	MRL
1,3-Dichloropropane	EPA 8260C	—	0.5	1.0
2,2-Dichloropropane	EPA 8260C	—	0.5	1.0
1,1-Dichloropropene	EPA 8260C	—	0.5	1.0
cis-1,3-Dichloropropene	EPA 8260C	—	0.5	1.0
trans-1,3-Dichloropropene	EPA 8260C	—	0.5	1.0
Ethylbenzene	EPA 8260C	7.3	0.25	0.5
Hexachlorobutadiene	EPA 8260C	—	2.5	5.0
n-Hexane	EPA 8260C	—	5.0	10.0
2-Hexanone	EPA 8260C	—	5.0	10.0
Isopropylbenzene	EPA 8260C	—	0.5	1.0
4-Isopropyltoluene	EPA 8260C	—	0.5	1.0
Methylene chloride	EPA 8260C	—	1.5	3.0
4-Methyl-2-pentanone (MiBK)	EPA 8260C	—	5.0	10.0
Methyl tert-butyl ether (MTBE)	EPA 8260C	—	0.5	1.0
Naphthalene	EPA 8260C	—	1.0	2.0
n-Propylbenzene	EPA 8260C	—	0.25	0.5
Styrene	EPA 8260C	—	0.5	1.0
1,1,1,2-Tetrachloroethane	EPA 8260C	—	0.2	0.4
1,1,2,2-Tetrachloroethane	EPA 8260C	—	0.25	0.5
Tetrachloroethene (PCE)	EPA 8260C	0.24	0.2	0.4
Tetrahydrofuran	EPA 8260C	—	5.0	10.0
Toluene	EPA 8260C	9.8	0.5	1.0
1,2,3-Trichlorobenzene	EPA 8260C	—	1.0	2.0
1,2,4-Trichlorobenzene	EPA 8260C	—	1.0	2.0
1,1,1-Trichloroethane	EPA 8260C	—	0.2	0.4
1,1,2-Trichloroethane	EPA 8260C	—	0.25	0.5
Trichloroethene (TCE)	EPA 8260C	0.6	0.2	0.4
Trichlorofluoromethane	EPA 8260C	—	1.0	2.0
1,2,3-Trichloropropane	EPA 8260C	—	0.5	1.0

Table B-5c

Porewater Samples in Contact with PTW-NAPL Sediments Analytes, Methods, and Targeted Reporting Limits

Parameter	Recommended Analytical Method	Groundwater Cleanup Levels[1]	MDL	MRL
1,1,2-Trichloro-1,2,2-trifluoroethane (Freon-113)	EPA 8260C	—	1.0	2.0
1,2,4-Trimethylbenzene	EPA 8260C	—	0.5	1.0
1,3,5-Trimethylbenzene	EPA 8260C	—	0.5	1.0
Isobutyl alcohol	EPA 8260C	—	250	250
Vinyl chloride	EPA 8260C-SIM	0.022	0.2	0.4
m,p-Xylene	EPA 8260C	—	0.5	1.0
o-Xylene	EPA 8260C	—	0.25	0.5
trans-1,4-Dichloro-2-butene	EPA 8260C	—	5.0	10.0
Total xylenes	EPA 8260C	13	0.75	1.5

Notes:

1. The Groundwater Cleanup Levels are presented in Table 17 of the *Record of Decision – Portland Harbor Superfund Site* (EPA 2017).

2. During the spring 2018 interim pre-remedial design data gaps field sampling work performed by NW Natural, transition zone water (TZW) samples were analyzed for PAHs with ROD Table 17 groundwater CULs using the EPA-approved methodologies proposed in this table. A very small percentage of the samples were reported as non-detects with MDLs greater than the CULs, and this percentage achieved the data quality objectives (see TEWP Appendix D for more details). None of the TZW samples from 2018 were in contact with sediments containing PTW-NAPL. Alternatively, as discussed in DGWP Sections 3.2.1.1.2 and 3.2.1.1.3, the proposed PAH analyses will only be performed on porewater samples in contact with PTW-NAPL, so concentrations are expected to be higher than those identified in 2018. Therefore, the proposed data should achieve the data quality objectives necessary to support remedial design.

3. cPAH (BaP eq), total PAHs, total PCBs, 2,3,7,8-TCDD eq, and DDx are calculated values; therefore, there are no MDLs or MRLs for these parameters.

µg/L: micrograms per liter
—: not applicable
EPA: U.S. Environmental Protection Agency
MDL: method detection limit
MRL: method reporting limit

Table B-6
Ebullition Sheen Testing Analytes, Methods, and Targeted Reporting Limits

Analyte	Analytical Method	Method Detection Limit	Target Reporting Limit
Total Petroleum Hydrocarbons (µg)			
Diesel-range organics (C10 to C28)	EPA 8015D Modified	TBD	TBD
Total petroleum hydrocarbons (C9 to C44)	EPA 8015D Modified	TBD	TBD

Notes:
EPA: U.S. Environmental Protection Agency
TBD: to be determined

Table B-7
Geotechnical Testing Analytes and Methods

Parameter	Recommended Analytical Method
Geotechnical	
Moisture content	ASTM D2216
Specific gravity	ASTM D854
Grain size	ASTM D6913 & D7928
Bulk density	ASTM D7263
Atterberg limits	ASTM D4318
Unconsolidated undrained (UU) triaxial	ASTM D2850
Consolidated undrained (CU) triaxial	ASTM D4767
Consolidated drained triaxial	ASTM D7181
1-D Consolidation	ASTM D2435
Direct shear	ASTM D3080
Seepage induced consolidation test (SICT)	Znidarcic, et. al., 1992

Note:
ASTM: ASTM International

Table B-8
Field and Laboratory Quality Control Sample Analysis Frequency

Analysis Type	Rinsate Blanks	Field Duplicates	Initial Calibration	Ongoing Calibration	LCS/SRM[2]	Duplicates	Matrix Spikes	Matrix Spike Duplicates	Method Blanks	Surrogate Spikes
Geotechnical and NAPL Mobility Analyses	—	—	—	—	—	—	—	—	—	—
pH/Ignitability	—	—	Daily	—	—	—	—	—	—	—
Total Solids/Total Suspended Solids	—	1 per 20 samples	Daily	—	—	1 per 20 samples	—	—	—	—
COD	—	—	Per instrument specifications	1 per 10 samples	1 per 20 samples	1 per 20 samples	—	—	1 per 20 samples	—
Total Organic Carbon/Dissolved Organic Carbon	—	1 per 20 samples	As needed[1]	1 per 10 samples	1 per 20 samples	1 per 20 samples	1 per 20 samples	—	1 per 20 samples	—
Metals	1 per 20 samples	1 per 20 samples	Daily or each batch	1 per 10 samples	1 per 20 samples	1 per 20 samples	1 per 20 samples	—	1 per 20 samples	—
Herbicides	1 per 20 samples	1 per 20 samples	As needed[1]	1 per 10 samples	1 per 20 samples	—	1 per 20 samples	1 per 20 samples	1 per 20 samples	Every sample
Pesticides	1 per 20 samples	1 per 20 samples	As needed[1]	1 per 10 samples	1 per 20 samples	—	1 per 20 samples	1 per 20 samples	1 per 20 samples	Every sample
PCB Aroclors	1 per 20 samples	1 per 20 samples	As needed[1]	1 per 10 samples	1 per 20 samples	—	1 per 20 samples	1 per 20 samples	1 per 20 samples	Every sample
TPH/SHCs	—	—	As needed[1]	1 per 10 samples	1 per 20 samples	—	—	—	1 per 20 samples	Every sample
VOCs	1 per 20 samples[3]	1 per 20 samples	As needed[1]	Every 12 hours	1 per 20 samples	—	1 per 20 samples	1 per 20 samples	1 per 20 samples	Every sample
SVOCs/PAHs	1 per 20 samples	1 per 20 samples	As needed[1]	Every 12 hours	1 per 20 samples	—	1 per 20 samples	1 per 20 samples	1 per 20 samples	Every sample
Alkylated PAHs, Biomarkers	1 per 20 samples	1 per 20 samples	As needed[1]	Every 12 hours	1 per 20 samples	—	1 per 20 samples	1 per 20 samples	1 per 20 samples	Every sample
Organotins	1 per 20 samples	1 per 20 samples	As needed[1]	Every 12 hours	1 per 20 samples	—	1 per 20 samples	1 per 20 samples	1 per 20 samples	Every sample

Table B-8
Field and Laboratory Quality Control Sample Analysis Frequency

Analysis Type	Rinsate Blanks	Field Duplicates	Initial Calibration	Ongoing Calibration	LCS/SRM[2]	Duplicates	Matrix Spikes	Matrix Spike Duplicates	Method Blanks	Surrogate Spikes
PCB Congeners	1 per 20 samples	1 per 20 samples	As needed[1]	Every 12 hours	1 per 20 samples	1 per 20 samples	—[4]	—[4]	1 per 20 samples	Every sample
Dioxin/Furans	1 per 20 samples	1 per 20 samples	As needed[1]	Every 12 hours	1 per 20 samples	1 per 20 samples	—[4]	—[4]	1 per 20 samples	Every sample

Notes:
1. Initial calibrations are considered valid until the ongoing continuing calibration no longer meets method specifications. At that point, a new initial calibration is performed.
2. When a standard reference material is available, it may be used in lieu of an LCS.
3. Trip blanks will be collected at a rate of one per cooler containing VOC sample aliquots.
4. Isotope dilution is required by the method.
—: not applicable
BOD: biochemical oxygen demand
COD: chemical oxygen demand
LCS: laboratory control sample
NAPL: nonaqueous phase liquid
PAH: polycyclic aromatic hydrobarbon
PCB: polychlorinated biphenyl
SRM: standard reference material
SHC: saturated hydrocarbon
SVOC: semivolatile organic compound
TPH: total petroleum hydrocarbon
VOC: volatile organic compound

Table B-9
Data Quality Objectives

Parameter	Precision (Duplicate RPD)	Accuracy (Spike Recoveries)	Completeness
Soils and Sediments			
Geotechnical and NAPL Mobility Analyses	—	—	95%
pH/Ignitability	± 20% RPD	—	95%
Total Solids	± 20% RPD	—	95%
TOC	± 25% RPD	70 to 130% R	95%
COD	± 25% RPD	70 to 130% R	95%
Metals	± 25% RPD	70 to 130% R	95%
PAHs	± 35% RPD	50 to 150% R	95%
PAHs/alkylated PAHs/Biomarkers	± 35% RPD	50 to 150% R	95%
SVOCs	± 35% RPD	50 to 150% R	95%
VOCs	± 35% RPD	50 to 150% R	95%
Dioxin/Furans	± 35% RPD	50 to 150% R	95%
PCB Congeners	± 35% RPD	50 to 150% R	95%
PCB Aroclors	± 35% RPD	50 to 150% R	95%
Pesticides	± 35% RPD	50 to 150% R	95%
Herbicides	± 35% RPD	50 to 150% R	95%
TPH/SHCs	± 35% RPD	50 to 150% R	95%
Organotins	± 35% RPD	50 to 150% R	95%
Waters and Elutriates			
pH	± 20% RPD	—	95%
TSS	± 20% RPD	—	95%
TOC	± 25% RPD	75 to 125% R	95%
Metals	± 25% RPD	75 to 125% R	95%
PAHs	± 30% RPD	60 to 140% R	95%
SVOCs	± 30% RPD	60 to 140% R	95%
VOCs	± 30% RPD	60 to 140% R	95%
Dioxin/Furans	± 30% RPD	60 to 140% R	95%

Table B-9
Data Quality Objectives

Parameter	Precision (Duplicate RPD)	Accuracy (Spike Recoveries)	Completeness
PCB Aroclors	± 30% RPD	60 to 140% R	95%
Pesticides	± 30% RPD	60 to 140% R	95%
Herbicides	± 30% RPD	60 to 140% R	95%
Sheen Nets			
TPH	± 35% RPD	50 to 150% R	95%

Notes:
--: not applicable
BOD: biochemical oxygen demand
COD: chemical oxygen demand
DOC: dissolved organic carbon
PAH: polycyclic aromatic hydrocarbon
PCB: polychlorinated biphenyl
R: recovery
RPD: relative percent difference
SVOC: semivolatile organic compound
TOC: total organic carbon
TPH: total petroleum hydrocarbon
TSS: total suspended solids
VOC: volatile organic compound

Table B-10
Guidelines for Solids Sample Handling and Storage

Parameter	Sample Size	Container Size and Type[1]	Holding Time	Sample Preservation Technique
Moisture content	100 g	1 to 4 gallons in zip-top bags	None	None
Specific gravity	100 g		None	None
Atterberg limits	100 g		None	None
Grain size	100 g		None	None
Bulk density	300 g	Shelby tubes	None	None
Unconsolidated undrained (UU) triaxial	100 g		None	None
Consolidated undrained (CU) triaxial	100 g		None	None
Consolidated drained triaxial	100 g		None	None
1-D Consolidation	100 g		None	None
Direct shear	100 g		None	None
SICT	100 g	16-oz glass or HDPE	None	None
Total Solids	50 g	16-oz glass	None	Cool < 6°C
Total Organic Carbon	50 g		28 days	Cool < 6°C
			6 months	Freeze -18°C
Cyanide	50 g		14 days	Cool 2 to 6°C
Metals	5 g		180 days	Cool < 6°C
SVOCs/ PAHs/ PCB Aroclors/ Pesticides/ TPH	200 g		14 days until extraction	Cool <6°C
			1 year until extraction	Freeze -18°C
			40 days after extraction	Cool <6°C
VOCs	5 g	40-mL VOA vial with PTFE-lined septum caps (2x)	14 days	Cool 2 to 6°C/ MeOH (1 vial)
TCLP Metals	100 g	8-oz glass	180 days to TCLP extraction	Cool <6°C
			180 days to analysis	HNO_3 to pH < 2
TCLP SVOCs, Pesticides	300 g	2 x 16-oz glass	14 days to TCLP extraction	Cool <2 - 6°C
			7 days to extraction	
			40 days after extraction	
TCLP VOCs	100 g	4-oz glass, no headspace	14 days to TCLP extraction	Cool <6°C
			14 days to analysis	HCl to pH < 2
DRET pH	5 gallons sediment + 10 gallons water	Sediment bags and cubitainers	14 days to DRET extraction	Ambient
			Analyze immediately	Cool < 2 - 6°C
DRET TSS			7 days to DRET extraction	Ambient
			7 days to analysis	Cool < 2 - 6°C
DRET VOCs			14 days to DRET extraction	Ambient
			14 days to analysis	HCl to pH < 2
DRET SVOCs, Pesticides, Herbicides, PCBs, TBTs			14 days to DRET extraction	Ambient
			7 days to extraction	Cool < 2 - 6°C
			40 days after extraction	
DRET Metals			180 days to DRET extraction	Ambient
			180 days to analysis	HNO_3 to pH < 2
DRET Dioxin/furans			1 year to DRET extraction	Ambient
			1 year to analysis	Cool < 2 - 6°C
PCB Congeners, Dioxin/furans and HR Pesticides	30 g	4-oz glass	1 year to extraction	Freeze -18°C
			1 year after extraction	
Organotins	150 g	8-oz glass	14 days until extraction	Cool <6°C
			1 year until extraction	Freeze -18°C
			40 days after extraction	Cool <6°C
PAHs/alkylated PAHs/Biomarkers/SHCs	100 g	4-oz glass	14 days until extraction	Cool <6°C
			1 year until extraction	Freeze -18°C
			40 days after extraction	Cool <6°C
pH/ Ignitability	25 g	8-oz glass	14 days	Cool 2 to 6°C
Perchlorate	50 g		28 days to extraction, 28 days after extraction	Cool <6°C
COD	10 g		28 days	Cool < 6°C
Herbicides	100 g	8-oz glass	14 days until extraction	Cool <6°C
			1 year until extraction	Freeze -18°C
			40 days after extraction	Cool <6°C
TCLP Herbicides	300 g	16-oz glass	14 days to TCLP extraction	Cool <2 - 6°C
			7 days to extraction	
			40 days after extraction	
Core slabbing and preparation	—	Undisturbed core sections	None	Cool < 6°C
Core photography with white light and UV	—	Undisturbed core sections	None	Cool < 6°C
Grain density	—	Undisturbed core sections	None	Cool < 6°C
Porosity	—	Undisturbed core sections	None	Cool < 6°C
Vertical permeability	—	Undisturbed core sections	None	Cool < 6°C
Capillary pressure	—	Undisturbed core sections	None	Cool < 6°C
Free product mobility via centrifuge	—	Undisturbed core sections	None	Cool < 6°C
Pore fluid saturations (NAPL and water)	—	Undisturbed core sections	None	Cool < 6°C
Dry bulk density	—	—	—	—
Hydraulic conductivity	—	—	—	—

Table B-10
Guidelines for Solids Sample Handling and Storage

Parameter	Sample Size	Container Size and Type[1]	Holding Time	Sample Preservation Technique
Fluid density/specific gravity	50 mL[2]	2 x 40-mL VOA vial	None	Ambient
NAPL Viscosity			None	Ambient
NAPL Interfacial tension			None	Ambient
Wettability (droplet method)			None	Ambient

Notes:
1. Container size, type, and sample size required may change based on program and laboratory guidance.
2. More or less may sent for analysis, depending on volume available.
—: not applicable
DRET: Dredging Elutriate Test
g: gram
L: liter
MeOH: methanol
$NaHSO_4$: sodium bisulfate
oz: ounce
PAH: polycyclic aromatic hydrocarbon
PCB: polychlorinated biphenyl
SHC: saturated hydrocarbon
SVOC: semivolatile organic compound
PTFE: polytetrafluoroethylene (Teflon)
TCLP: Toxicity Characteristic Leaching Procedure
VOA: volatile organic analysis
VOC: volatile organic compound

Table B-11
Guidelines for Aqueous Sample Handling and Storage

Parameter	Sample Size	Container Size and Type[1]	Holding Time	Sample Preservation Technique
Total Suspended Solids	1 L	1-L HDPE	7 days	2 to 6°C
Total Organic Carbon	10 mL	2 x 40-mL VOA vial	28 days	2 to 6°C; H2SO4 to pH < 2
Dissolved Organic Carbon	10 mL	2 x 40-mL VOA vial	28 days	Field filter; 2 to 6°C; H2SO4 to pH < 2
Metals	100 mL	500-mL HDPE	180 days	Cool 2 to 6°C; HNO3 to pH < 2
pH	10 mL	250-mL HDPE	ASAP	Cool 2 to 6°C
VOCs	5 mL	40-mL VOA vial with PTFE-lined septum caps (3x)	14 days	Cool 4 to 6°C/HCl to pH < 2
SVOCs	1L	2 x 1-L Amber glass	7 days until extraction	Cool 2 to 6°C
			40 days after extraction	
PAHs	1L	2 x 1-L Amber glass	7 days until extraction	Cool 2 to 6°C
			40 days after extraction	
Pesticides	1L	2 x 1-L Amber glass	7 days until extraction	Cool 2 to 6°C
			40 days after extraction	
PCB Aroclors	1L	2 x 1-L Amber glass	14 days until extraction	Cool 2 to 6°C
			40 days after extraction	

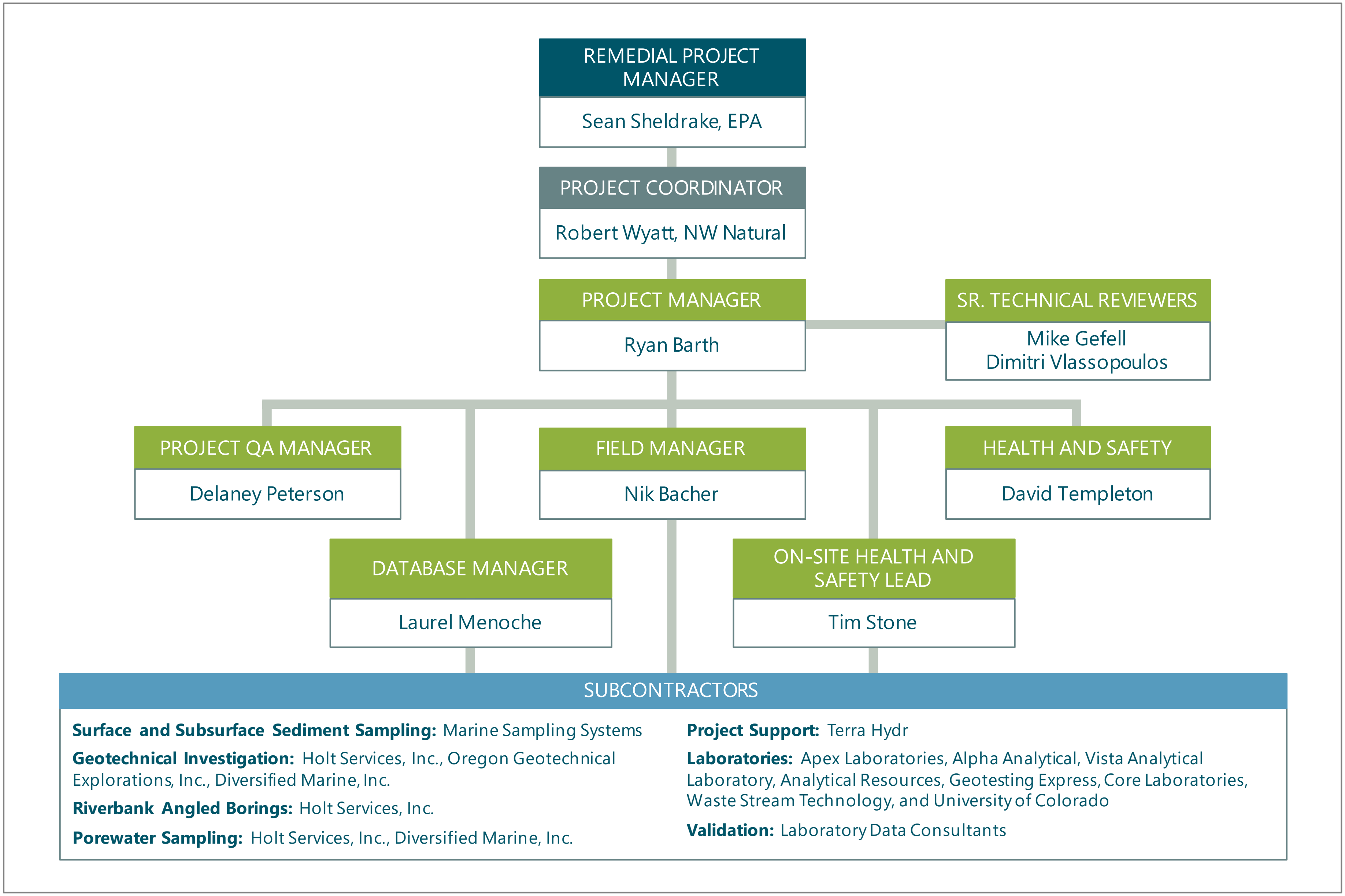
Notes:
1. Container size, type, and sample size required may change based on laboratory guidance.
HDPE: high-density polyethylene
L: liter
mL: milliliter
PAH: polycyclic aromatic hydrocarbon
PCB: polychlorinated biphenyl
PTFE: polytetrafluoroethylene (Teflon)
SVOC: semivolatile organic compound
VOA: volatile organic analysis
VOC: volatile organic compound

Table B-12
Guidelines for Sheen Net Sample Handling and Storage

Parameter	Sample Size	Container Size and Type[1]	Holding Time	Sample Preservation Technique
Total petroleum hydrocarbons	1 Net	8-oz glass	No established hold time to extraction	Cool 2 to 6°C
			40 days after extraction	

Notes:
1. Container size, type, and sample size required may change based on laboratory guidance.
oz: ounce

Figure



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ANCHOR QEA

Figure B-1
Project Organizational Chart
Pre-Remedial Design Data Gaps Quality Assurance Project Plan
Gasco Sediments Cleanup Action

Attachment A
Pre-Remedial Design Data Gaps
Data Management Plan

ECSI No. 84
June 3, 2019
Gasco Sediments Cleanup Action

Pre-Remedial Design Data Gaps Data Management Plan

Prepared for U.S. Environmental Protection Agency, Region 10

ECSI No. 84
June 3, 2019
Gasco Sediments Cleanup Action

Pre-Remedial Design Data Gaps Data Management Plan

Prepared for
U.S. Environmental Protection Agency
Region 10
1200 Sixth Avenue
Seattle, Washington 98101

On Behalf of
NW Natural
2200 SW Second Avenue
Portland, Oregon 97209

Prepared by
Anchor QEA, LLC
6720 SW Macadam Ave
Suite 125
Portland, Oregon 97219

TABLE OF CONTENTS

ABBREVIATIONS

CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COC	chain of custody
DMP	*Data Management Plan*
EDD	electronic data deliverable
EPA	U.S. Environmental Protection Agency
ICP	inductively coupled plasma
JPEG	Joint Photographic Experts Group
PDF	portable document format
Port	Port of Portland
QA	quality assurance
QC	quality control
RPD	relative percent difference
SDU	Sediment Decision Unit
SOW	*Statement of Work – Gasco Sediments Site*
QAPP	*Pre-Remedial Design Data Gaps Quality Assurance Project Plan*
SSF	Standard Storage Format
TEWP	*Final Revised Pre-Remedial Basis of Design Technical Evaluations Work Plan*
TIFF	Tagged Image File Format
Work Plan	*Pre-Remedial Design Data Gaps Work Plan*

1 Introduction

This *Pre-Remedial Design Data Gaps Data Management Plan* (DMP) provides the data management process and procedures for the performance of work activities associated with data collection and reporting for the pre-remedial design data gaps investigation for the Gasco Sediments Site located on the Willamette River adjacent to the NW Natural Gasco and Siltronic Corporation properties in Portland, Oregon. This DMP has been prepared under the *Administrative Settlement Agreement and Order on Consent* (Docket No. Comprehensive Environmental Response, Compensation, and Liability Act [CERCLA] 10-2009-0255) and *Statement of Work – Gasco Sediments Site* (SOW; EPA 2009) and the Schedule of Deliverables approved by the U.S. Environmental Protection Agency (EPA) on June 19, 2017.

The procedures and policies described in this DMP are consistent with the "National Oil and Hazardous Substances Pollution Contingency Plan" (40 Code of Federal Regulations 300).

1.1 Project Background

NW Natural is conducting a pre-remedial design data gaps investigation within the Gasco Sediments Site, under the direction of EPA. This DMP describes the data management procedures to support sediment remedial design and is Attachment A to the *Pre-Remedial Design Data Gaps Quality Assurance Project Plan* (QAPP).

The Pre-Remedial Design Data Gaps Work Plan (Work Plan) has been prepared under the Administrative Settlement Agreement and Order on Consent (Docket No. CERCLA 10-2009-0255) and SOW (EPA 2009), as well as the Schedule of Deliverables approved by EPA on June 19, 2017. The Work Plan summarizes the remaining data gaps identified in the Final Revised Pre-Remedial Basis of Design Technical Evaluations Work Plan (TEWP; Anchor QEA 2019) and the associated field sampling methodologies to fill those data gaps at the Gasco Sediments Site. The data gaps sampling is being implemented to collect additional site-specific data within the EPA-identified Gasco Project Area to refine the Gasco Sediments Site active cleanup boundaries identified in the draft Engineering Evaluation/Cost Estimate, Gasco Sediments Cleanup Site (Anchor QEA 2012) and subsequently refined in the Record of Decision – Portland Harbor Superfund Site, Portland, Oregon (EPA 2017), as well as to support completion of the technical evaluations presented in the TEWP.

1.2 Data Management Objectives

This DMP describes the management of data resulting from pre-remedial design data gaps field investigations conducted under EPA-approved work plans and QAPPs. This DMP may be revised, amended, and updated as the pre-remedial design data gaps field investigations and/or remedial design process evolves and additional pre-remedial design data gaps investigation and/or remedial design activities are identified.

2 Personnel

2.1 Project Personnel

Responsibilities of the team members, as well as laboratory project managers, are described in Section 2.1 of the QAPP. Project roles specific to implementation of this DMP are described in Section 2.3 of this document.

The Anchor QEA Project Quality Assurance (QA) Manager and the Anchor QEA Database Manager will manage field and laboratory data records, including electronic data deliverables (EDDs). Only trained, authorized data managers have privileges to load and update data in the central database. Only trained, authorized developers have privileges to develop and modify applications and reporting code used in the data management system. Designated staff will be responsible for the storage and security of project hard copy and electronic files. A senior data manager will be responsible for QA of the database and applications. A senior chemist will be responsible for QA of the analytical chemistry data and records.

Project records will be accessible only to approved project personnel.

2.2 Training

Staff involved in data management tasks will have appropriate training in data and document stewardship, including the principles and procedures described herein, and in the systems that are used to manage electronic data. Data management systems comprise both hardware and software, as well as electronic file storage systems. Applications may be commercially or publicly available products or custom software developed by Anchor QEA and are used for data collection, data processing, data storage, data analysis, and data reporting. The data management systems that are used to support this project are described in Section 4. The procedures used during data management are described in Section 5.

Training includes formal academic or professional accreditation coursework, as well as internal training developed by Anchor QEA expressly for its data management systems.

Staff that have access to data-related applications will have been trained in the proper use of those applications. Staff that develop code will have been trained in standard programming techniques and practices. Staff that manage databases will have been trained in the proper use of database-related hardware (database servers) and software.

2.3 Roles and Responsibilities

The data management roles and responsibilities of the staff involved in data-related activities are as follows.

- Project Manager—Responsible for maintaining direct lines of communication between Anchor QEA and NW Natural, implementing activities described in this DMP, producing project deliverables, and performing the administrative tasks needed to ensure timely and successful completion of the work. The (Anchor QEA) Project Manager will provide the overall programmatic guidance to support staff and will ensure that documents, procedures, and project activities meet the objectives contained within this DMP.
- Database Manager—Responsible for data management oversight, including responsibility for database management functions, database quality, data transformations and calculations, applications functionality, and data reporting.
- GIS Manager—Responsible for spatial data management oversight, including coordinate verification, meta-data generation, maintenance of proper project coordinate systems and datums, and spatial data transmittal.
- Database Analyst—Responsible for loading field and laboratory analytical EDDs, performing database quality checks, updating the database as necessary, comparing database records against laboratory hard copy reports, and running reports from the database.
- Field Coordinator—Responsible for the documentation of proper sample collection protocols, sample collection, equipment decontamination, and chain-of-custody (COC) documentation. The Field Coordinator is also responsible for the proper use of field data collection applications and equipment, and the review of field notebooks, COC records, sample labels, and other field-related documentation. In addition, the Field Coordinator is responsible for the review and oversight of project plans and revisions to the plans to maintain proper QA throughout the investigation, field audits, data processing QC, data quality review, and identifying corrective actions.
- Field Team Staff—Responsible for collecting field data including samples for analysis, field measurements, and observations of the study area.
- Project QA Manager—Primary point of contact with the analytical laboratory(ies), responsible for laboratory procurement and monitoring of progress, reviewing laboratory receipt acknowledgments and COCs, and reviewing data for quality issues. In addition, the Project QA Manager is responsible for managing the data validation task, including ensuring that validation of analytical data is conducted and documented according to the requirements of the QAPP, and coordinating the QA/quality control (QC) efforts between Anchor QEA and subcontractors, including analytical laboratories. The Project QA Manager is further responsible for providing qualifiers and any other edits resulting from data validation to the Database Manager or Database Analyst.

- Laboratory Project Manager—Acts as the primary point of contact at a laboratory facility for the Project QA Manager to communicate and resolve sampling, receipt, analysis, and storage issues.

3 Project Documentation and Records

This section describes the types of documentation that will be included for project-specific and historical datasets, the databases that will be used, how the data will be archived, and database input requirements.

3.1 Project Data

This section describes the documentation and record keeping requirements for field-related data collected during the pre-remedial design data gaps investigation, in accordance with the SOW (EPA 2009).

3.1.1 Types of Documents to Be Created or Collected

Field data will be documented and recorded in various ways during the pre-remedial design data gaps investigation. The following list shows the kinds of field documents and records that may be produced during project data-gathering activities (additional information regarding the maintenance of project documents and records is provided in QAPP Section 2.6):

- Airbills
- COC records
- Communication logs/emails
- Corrective action communications
- Documentation of corrective action results
- Deviation forms
- Documentation of internal QA reviews and/or audits
- EDDs
- Field data collection forms
- Sampling notes in bound, waterproof field log books
- Field instrument calibration logs
- GPS files
- Identification of QC samples
- Identification of EPA split samples
- Photographs
- Sampling equipment decontamination records
- Sampling location figures (based on targeted and actual coordinates)

These records will be created in either written (e.g., sampling notes) or electronic formats (e.g., GPS files, measurement instrument/data-logger files, and field databases).

3.1.2 Database for Field Data and Analytical Data

Anchor QEA will maintain field and analytical data in a widely used, commercially available environmental data management system.[1] This system will contain information about locations, field measurements, samples, and laboratory tests and results. Access to the database will be restricted to data management personnel. In general, project personnel will have the ability to view, but not modify, the data. The ability to add or correct data will be granted to only those individuals identified by the Database Manager and trained to perform those tasks.

3.1.3 Project Data File Archives

Original field data documents will be archived in Anchor QEA's project files (e.g., field sheets, hard copy maps, and field log books), and electronic files (e.g., field data collection applications, electronic data logger files, GPS files, and photographs) will be archived on a secured server in a project-dedicated folder and/or on Anchor QEA's SharePoint site using an appropriate file type (e.g., Standard Storage Format [SSF] for GPS files; Tagged Image File Format [TIFF] or Joint Photographic Experts Group [JPEG] for photographs; and Excel or InfoPath formats for electronic field forms). In addition, all paper field records will be scanned and stored electronically (as portable document format [PDF] files) with other project electronic files, as indicated above. Documents (including records or documents in electronic form) will be maintained at Anchor QEA offices or at NW Natural for a minimum of 10 years after EPA's notification of completion of work, in accordance with the retention of records section of the SOW (EPA 2009).

3.1.4 Field Electronic Data Deliverables

Field data will be uploaded to the data management system into one or more field EDD formats that are generated from field data collection applications or by transcription from hand-written field forms. Data transferred from written records to field data EDDs will be reviewed against field records prior to being loaded into the database. The EDDs will be checked for valid values and proper format and will be rejected prior to loading if there are errors. The data management system is configured to require that all field samples (normal environmental as well as field QC samples) must be present in the database prior to the loading of laboratory results for those samples to avoid sample identification discrepancies between field and laboratory records.

3.1.5 Laboratory Electronic Data Deliverables

For analytical data, each laboratory will provide an EDD and one copy of a Level IV, contract laboratory program type data package (unless otherwise specified in the QAPP). While each laboratory is responsible for ensuring all data reported in the electronic copy and data package match, as part of data quality review, Anchor QEA will compare a subset of laboratory packages for

[1] EarthSoft EQuIS Enterprise version 6.6.1, as of the date of this document.

consistency between EDDs and data package reports. The data deliverable will include a summary package that contains, at a minimum, the case narrative, custody documentation, method citations, field and laboratory sample identifiers cross-reference, sample results (including all raw data needed to support those results), preparation and analysis dates, and summary QC forms. The data package will be provided to Anchor QEA as a bookmarked PDF file.

Complete, paginated data packages will contain the following minimum information:

- A narrative addressing any difficulties encountered during sample analysis and a discussion of any exceedances in the laboratory QC sample results
- A cross-referenced table of field and laboratory identification numbers
- Analytical method references
- Definition of any data flags or qualifiers used; a list of valid data flags and qualifiers for use in the EQuIS reporting format will be provided by Anchor QEA following contract award
- A table of contents for the data package similar to the EPA Complete Sample Delivery Group File Audit Checklist
- A COC signed and dated by the laboratory to indicate sample receipt; the temperature of the cooler upon receipt will be noted on the COC or on a sample receipt form; copies of shipping air bills will also be provided, if available
- Results for each field sample, blank and QC sample in units appropriate to the method presented in Form 1s or equivalent; method detection limits, estimated detection limits, and reporting limits will also be provided
- Dilution factors for each sample or analyte
- Calibration data, including raw data; initial calibration curve data, such as linear regression statistics or average relative response factors and percent relative standard deviation; continuing calibration data, such as relative response factors and percent difference data
- Gas chromatography/mass spectrometry and inductively coupled plasma/mass spectrometry tuning data
- Internal standard data
- Surrogate (system monitoring) data
- Inductively coupled plasma (ICP) inter-element correction factors, linear range data, serial dilution data, and interference check sample results
- Copies of laboratory notebook pages or preparation logs showing sample preparation documentation
- Field sample results and raw data (chromatograms and ICP printouts), including dilution data
- Laboratory QC data, including method blank data, laboratory duplicate data reported as relative percent difference (RPD), laboratory control spike data, reported as percent recovery; matrix spike/matrix spike duplicate data reported as percent recovery with RPD calculated; all associated raw data must also be provided

- Copies of phone logs, faxes, and emails associated with the sample set
- Any other data necessary to conclusively confirm the analytical results reported and the overall quality of the data

Anchor QEA has an analytical chemistry EDD specification that will be provided to each laboratory. The specification includes a descriptive memorandum, an EDD template, and a current file of valid reference values. Verification of EDD formatting and completeness will be performed by Anchor QEA data management personnel during upload or by automated EDD checking and loading procedures. Laboratory EDDs that do not meet the EDD specification or contain errors will not be loaded to the database and will be returned to the laboratory for correction and resubmittal.

3.2 Document Retention

Original field data documents (e.g., field sheets, hard copy maps, and field log books) will be archived in Anchor QEA's hard copy project file storage facility or at NW Natural. Electronic files (e.g., field data collection applications, EDDs, electronic data logger files, electronically produced documents, GPS files, and photographs) will be archived on a secured server in a project-dedicated folder using an appropriate, standard file type (e.g., PDF, SSF for GPS files, and TIFF or JPEG for SOW (EPA 2009). Specifically, until 10 years after receipt of EPA's notification of completion of work, NW Natural (and its contractors) shall preserve and retain at least one copy of all records and documents (including records or documents in electronic form) now in its possession or control or which come into its possession or control that relate in any manner to the performance of the sediment remedial design work or the liability of any person under CERCLA with respect to the Gasco Sediments Site, regardless of any internal retention policy to the contrary. Non-identical copies of documents will be maintained for a minimum of 10 years. Documents include hard copy documents, records, and other information in electronic form. Retention standards for documents created by subcontractors will be communicated to the subcontractors during contracting.

4 Data Management Systems

The environmental data management system is composed of a number of hardware and software components, as described here. System hardware includes servers and storage devices, computers and tablets, and networking and internetworking devices. Software includes operating systems, server and data storage applications, user data access and analysis applications, and field data collection applications.

4.1 Hardware

The hardware systems that comprise the data repositories include file servers and database servers. Key elements of these systems, specifically the analytical chemistry database and the GIS, are housed in a physically and electronically secure data center on enterprise-level hardware. The data center is remotely located and equipped with redundant power supplies and internet connections. Access to systems hardware and software in the data center is limited to designated, authorized personnel. File servers used to store and share project documents are either maintained on premises in a physically and electronically secure, dedicated server room or use cloud-based storage systems. Only designated personnel have access to project folders and files on file servers.

The networks within which servers reside are protected by firewalls and more than one level of malware detection and protection software and includes coverage for email servers, networks, and computers.

Computers and tablets used in field activities are dedicated to such activities and are secured by login requirements. Data stored on computers, tablets, GPS devices, and instrument data loggers will be exported and stored in project file servers as soon after each field activity as is practical; USB flash memory devices may be used for intermediate, temporary data storage in the field. Project data will not be commingled with data from other projects. Data will be stored in raw form (in the format in which it was generated) and in EDD formats suitable for loading to the project database.

Some in situ sensors may telemeter data to a third-party vendor. In such cases, these data will be accessible from a password-protected website. Data will be downloaded to the project database or file server for storage.

4.2 Software

4.2.1 Licensed Software

Licenses and active software maintenance agreements, where applicable, are required for all computers used in project work. Operating systems on servers and computers are updated with security and functional patches as provided by vendors after internal evaluation. Licensed applications are used for the database management system and GIS. The relational database management system is Microsoft SQL Server 2016. The data management application is EarthSoft EQuIS Enterprise version 6.6.1 with the Live extension. The GIS is Esri ArcGIS version 10.5.1. The data models and software for these systems are proprietary to the vendor and cannot be shared.

4.2.2 Custom Software

Custom applications will be used in this project. These applications are proprietary and are the intellectual property of Anchor QEA; their source code cannot be distributed. These applications include data loaders and checkers, data manipulation software, data analysis scripts, and field data collection applications.

Source code for data collection, data loading, and data reporting applications undergo several QC steps, including design review, code review, testing, and user acceptance testing. The source codes are version-controlled to track changes.

5 Data Management Procedures

This section describes the procedures for handling and tracking project data and documents.

5.1 Field Data Quality Review

QC checks will be performed as soon after field activities as is practical. The checks and the person responsible for performing them are outlined as follows:

1. Review field records for completeness and accuracy of information reported on field forms or in electronic applications with respect to requirements specified in the QAPP (Field Coordinator).
2. Ensure that corrections are made. For hard copy forms, corrections will be made with a single strikethrough and each corrected entry will be signed or initialed and dated. For electronic data, corrections are made in the application or in the EDD (Field Coordinator).
3. Compare field activities against the QAPP (Field Coordinator).
4. Scan hard copy forms and place scanned forms and electronic files into project-specific folders in the file server (Field Coordinator).
5. Review field records for conformance to standard nomenclature defined in QAPP (Database Manager).
6. Review in situ sensor data logger files for instrument issues (Field Coordinator).
7. Verify GPS coordinates (GIS Manager).
8. Review COCs and laboratory receipt acknowledgments (Project QA Manager).
9. Ensure that project documents are properly saved in project folders (Database Manager).

The Field Coordinator, Database Manager, and Project QA Manager, as appropriate, will be responsible for ensuring that corrections are made in response to issues identified in the steps above.

5.2 Field Data Processing

Procedures for field data collection and creation of field records are described in the QAPP. Management of these data are described as follows.

Field data are processed according to the following general steps. These may be performed after QC checks are completed but may be performed with unverified field data in support of the QC steps outlined in Section 5.1.

1. Send GPS files with coordinates to the GIS team (Field Team).
2. Prepare field EDDs and transmit to the database team. If field forms were used, the Field Team transcribes information to be stored in the central database into specifically formatted, Microsoft Excel field EDD templates. If field data collection applications were used, export the data into the appropriate EDD format (Field Team).

3. Place hard copy files, data logger files, and image files in designated project folders (Field Team).
4. Load field EDDs to the database (Database Analyst).

Field EDDs will include, at a minimum and as specified in the project QAPP, the following items:

- Location information (e.g., location identifier, coordinates [in the appropriate project coordinate system], depth or elevation with units in the appropriate datum)
- Boring/coring information (e.g., date/time, technique, driller, geologist, depths, recoveries, and lithology)
- Sample information (e.g., location, depth[s], sample type, and, if duplicate, the associated normal parent sample)
- For biota samples, collection method, species information, sample preparation (if performed in the field), measurements, counts, and compositing information, as required
- Visual observations
- Field parameter measurements (unless these are provided in a separate data logger file)
- COC/test request information

Anchor QEA's field data collection applications support project-specific location and sample nomenclature and valid values. In addition, electronic forms and field EDDs cannot be created unless all required elements are provided. Anchor QEA's field and laboratory data loaders support detailed checks of locations, valid values, samples, and test requests. Field sample information and test requests must be loaded to the database prior to the loading of laboratory EDDs.

Other types of electronic field data may be collected (e.g., hydrographic survey data, GIS data, aerial photographs, current meter data, and water column profiles). These data will be saved to designated project folders.

5.3 Laboratory Data Processing and Data Validation

The following steps are performed on data received from laboratories or from data validators. COCs, laboratory receipt acknowledgements, laboratory reports and EDDs, and data validation reports and EDDs are stored in designated project files. If any revisions to these files are made, the original files are retained.

1. Coordinate with laboratory regarding schedule, issues, and receipt of data (Project QA Manager).
2. Load laboratory EDDs to the database (Database Analyst).
3. Prepare validation export EDD (Database Analyst).
4. Perform data validation. This step may be performed in-house or sent to a subcontractor for validation (Data Validator).

5. Review validation results. This step is performed regardless of whether validation is performed in-house or by a subcontractor (Project QA Manager).
6. Load validation results (Database Analyst).
7. Review database records against laboratory report for consistency (Database Analyst).
8. Perform any data transformations or processing necessary to support data analysis (Database Analyst).

Anchor QEA's laboratory analytical EDD loader applications can be configured to perform several completeness and quality checks. To assist laboratories with Anchor QEA's EDD requirements, documentation of laboratory EDD specifications is provided to project laboratories during laboratory contracting or before the inception of the project. Analytes, including target, surrogate, and other method-specific QC analytes, as well as matrices and units must be reported as stated in the project QAPP. A laboratory EDD will not be loaded to the database if it does not, at a minimum, match the proper EDD file-naming convention, formatting, valid values, and field sample identifier. Depending on the laboratory and the tests requested, the loader application may require that all analytical reporting requirements have been met before accepting the EDD. Any errors will be communicated to the laboratory by the Project QA Manager or Database Manager, and it is the responsibility of the laboratory to submit a proper EDD. All revisions of EDDs are maintained in designated project folders.

The Project QA Manager will review laboratory data packages for proper formatting and completeness, as specified in the project QAPP. Any errors will be communicated to the laboratory for revision and resubmittal.

Data validation will be performed as required in the project QAPP. The Project QA Manager will be responsible for ensuring that validations are performed properly and at the required frequency and level of evaluation. The Project QA Manager will work with the Database Manager for the preparation and loading of validation EDDs, ensure that validation reviews are performed, and communicate any validation issues to the Data Validator.

The final analytical data quality review is a verification of database records against laboratory and validation reports. This step is performed by the Database Analyst. Issues encountered in this step will be communicated to the Project QA Manager and Database Manager for resolution. When data pass this step, they are ready for evaluation and analysis by project personnel and ready for reporting and transmittal to other parties.

Anchor QEA records the status and workflow of laboratory and data validation deliverables at the sample delivery group level in a custom tracking application, from laboratory receipt acknowledgement to final data quality review by recording the date and person that completed each step in the process.

5.4 Geospatial Data

Geospatial information will be stored in an Esri ArcGIS system. The project coordinate system is the Oregon North Zone state plane in international feet with the High-Accuracy Reference Network (1991) adjusted 1983 North American Datum as the horizontal datum. The vertical datum is the City of Portland datum.[2] Spatial data will be transmitted in the ESRI File Geodatabase format.

The GIS Manager will oversee field-generated coordinate verification procedures and will work with the Database Manager to ensure that accurate, verified coordinates are stored with location information in the project database.

5.5 Imagery

Photographic and videographic image files may be created in this project. Original files, produced by equipment suitable for the quality objectives, will be retained unedited in project folders. Edited files will be stored as revisions.

5.6 Database Modifications

Modifications to the database after final data quality review, while rare, may occur. These may occur after holistic review of the data during evaluations that may reveal issues with the data not detected during the formal data validation process. Potential issues will be discussed with the Project Manager prior to modifying the database. Modifications may occur after data have been transmitted. A project database change log is maintained that records the release or transmittal dates of a dataset and the dates and nature of changes made to the database.

Notification of database modifications to affected parties will be made through email or a memorandum as soon as is practicable.

[2] https://www.portlandoregon.gov/transportation/article/70676 (viewed May 2019)

6 Data Protection and Security

The information systems that contain and support project data, including field and analytical data as well as other electronic information, include systems within Anchor QEA's offices, in a data center facility, and an off-site storage location for tape backups. The procedures that protect and secure these information systems are described below.

6.1 Computer Systems

Servers in Anchor QEA's facilities are physically secured in locked buildings and rooms, with access limited to authorized personnel. Servers are electronically secured behind firewalls with multiple layers of anti-malware software that protect the firewall, the local area networks, and emails. Servers and networking equipment are connected to battery-based uninterruptable power supplies with automated shutdown procedures in the event of a power outage.

Operating system and third-party software are licensed and maintained with vendor-supplied security patches. Major updates are evaluated and tested, and project managers are consulted regarding the impact of major updates prior to deployment on production servers.

Access to these servers is limited to authorized system administrators through physical locks and through network domain permissions. Access to central data management systems is limited by permissions to authorized project-specific data management personnel.

6.2 Physical Files

Physical files stored on premises or in an off-sight storage facility are physically protected to the extent practicable by security systems and fire prevention systems. Historical documents and images will be protected from light to prevent damage. To the extent practical, physical documents will be scanned, and those scanned documents will be protected through electronic storage backup systems.

6.3 Privacy and Confidentiality

It is not anticipated that the data collected will pose privacy concerns. Once data and documents are reviewed for quality, as described elsewhere in this document, they will be transmitted to EPA. No data generated during this project are considered confidential. Proprietary software used to evaluate data are considered confidential.

7 Data Reporting and Transmittal

Reporting and the submittal of data to EPA will be performed as specified in the SOW (EPA 2009) as well as the Schedule of Deliverables approved by EPA on June 19, 2017.

7.1 Sampling, Monitoring, and Analytical Data

As specified in the SOW (EPA 2009) as well as the Schedule of Deliverables approved by EPA on June 19, 2017, analytical chemistry and field monitoring data along with sample and location information from the pre-remedial design data gaps field investigations will be provided, following validation, to EPA in a Pre-Remedial Design Data Gaps Sampling and Analysis Report.

7.2 Spatial Data

Spatially referenced and geospatial data will be submitted as specified in the SOW (EPA 2009) as well as the Schedule of Deliverables approved by EPA on June 19, 2017. Spatial data will be transmitted in the ESRI File Geodatabase format, with decimal-degree geographic coordinates World Geodetic System 1984 as the datum. Metadata compliant with Federal Geographic Data Committee Content Standard for Digital Geospatial Metadata and the EPA Geospatial Metadata Technical Specification will be included with spatial data transmittals.

8 References

Anchor QEA (Anchor QEA, LLC), 2019. *Final Revised Pre-Remedial Basis of Design Technical Evaluations Work Plan*. Prepared for EPA Region 10 on behalf of NW Natural. June 2019.

Anchor QEA, 2012. *Engineering Evaluation/Cost Estimate*. Draft. Gasco Sediments Cleanup Site. Prepared for EPA Region 10 on behalf of NW Natural. May 2012.

EPA (U.S. Environmental Protection Agency), 2009. *Statement of Work – Gasco Sediments Site*. U.S. Environmental Protection Agency Region 10. September 9, 2009.

EPA, 2017. *Record of Decision – Portland Harbor Superfund Site*. January 2017.

Appendix C
Pre-Remedial Design Data Gaps
Health and Safety Plan

ECSI No. 84
August 22, 2019
Gasco Sediments Cleanup Action

ANCHOR QEA

Pre-Remedial Design Data Gaps Health and Safety Plan

Provided to U.S. Environmental Protection Agency, Region 10

PLAYING IT SAFE

Responsibility Is Taken, Not Given
Take Responsibility For Safety

ECSI No. 84
August 22, 2019
Gasco Sediments Cleanup Action

Pre-Remedial Design Data Gaps Health and Safety Plan

Prepared for
U.S. Environmental Protection Agency
Region 10
1200 Sixth Avenue
Seattle, Washington 98101

Prepared by
Anchor QEA, LLC
6720 SW Macadam Avenue
Suite 125
Portland, Oregon 97219

On Behalf of
NW Natural
220 NW 2nd Avenue
Portland, Oregon 97209

Project Number: 000029-02.59
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Certification Page

Ryan Barth

Project Manager

Anchor QEA, LLC

Date: August 22, 2019

Nik Bacher

Field Lead

Anchor QEA, LLC

Date: August 22, 2019

The information in this Health and Safety Plan has been designed for the Pre-Remedial Design Data Gaps Work Plan (Scope of Work) presently contemplated by Anchor QEA, LLC (Anchor QEA). Therefore, this document may not be appropriate if the work is not performed by or using the methods presently contemplated by Anchor QEA. In addition, as the work is performed, conditions different from those anticipated may be encountered and this document may have to be modified. Therefore, Anchor QEA only intends this plan to address currently anticipated activities and conditions and makes no representations or warranties as to the adequacy of the Health and Safety Plan for all conditions encountered.

Health and Safety Plan Acknowledgement Form

Project Number: 000029-02.56

Project Name: Gasco Sediments Cleanup Action

My signature below certifies that I have read and understand the policies and procedures specified in this Health and Safety Plan (HASP). For non-Anchor QEA employees, this HASP may include company-specific appendices to this plan developed by entities other than Anchor QEA. Non-affiliated personnel may be required to sign the Liability Waiver following this Acknowledgement Form.

Date	Name (print)	Signature	Company

Date	Name (print)	Signature	Company

Liability Waiver

Release from Liability, Waiver of Claims, and Indemnification

This liability release, waiver, and indemnification is required for participation in our field trips and site tours. Each participant must sign his/her own form.

In return for receiving permission from **Anchor QEA, LLC** (**"Anchor QEA"**), a Washington State Limited Liability Company, to participate in the field trip that is to take place at ____ (location) on ________________________ (date) (collectively, the **"Activities"**), the undersigned participant (**"Participant"**), acting through and/or with the consent of his/her parent or legal guardian (if Participant is a minor or the subject of a guardianship), hereby agrees as follows:

1. I fully recognize the dangers of participating in the Activities, and I voluntarily assume all risks associated with my participation in the Activities. I understand that the dangers that I may encounter at the site(s) where the Activities take place (in each case, a **"Site"**) include, by way of example only and without limitation: exposure to contaminants; exposure to aerosol vapors; wild animals, poisonous snakes, and harmful insects; poisonous vegetation; drowning, sea sickness, and boating accidents; falling from steep slopes, cliffs, or narrow trails; landslides; rough terrain; lightning; wildfire; extremes of temperatures; and storms. I realize that there is also a risk of my becoming seriously ill or injured in an area remote from medical care and that Anchor QEA cannot guarantee the availability of emergency medical services or emergency transportation to medical facilities.
2. I agree that neither Anchor QEA nor any of its agents, representatives, partners, contractors, consultants, or employees: (a) shall have any liability for any defect or dangerous natural or artificial condition relating to any Site or any of the Activities; or (b) have made or are making any representation or warranty, expressed or implied, regarding: (i) the conditions of any Site; (ii) the safety of the Activities or any of the equipment to be used in connection with the Activities; (iii) any means of transportation to or from any Site; or (iv) any other aspect of any Site or any of the Activities.
3. I agree to take the responsibility to familiarize myself with the rules and regulations applicable to the Sites and the Activities, and to ensure that I have been properly instructed in and understand the use of any equipment I am to use in the Activities. I realize that my participation in the Activities may require sustained strenuous physical activity. I am in good health, and am not aware of any physical or medical condition that might endanger myself or other participants in the Activities.
4. Acting for myself and my heirs, executors, personal representatives, and assigns, I forever release and discharge Anchor QEA and its agents, representatives, partners, contractors, consultants, or

employees, and the successors and assigns of each of them (in each case, a **"Released Party"**), of and from all claims, losses, damages, costs, expenses, and other liabilities, including (but not limited to) reasonable attorneys' fees (in each case, a **"Claim"**), whether known or unknown, foreseen or unforeseen, relating to property damage or the death, injury, pain, or mental trauma of myself or any other person, and resulting, directly or indirectly, from my participation in the Activities or my travel to or from any Site. Without limiting the above, I agree not to sue any of the Released Parties for any such Claims, to waive any such Claims that I may have at any time against any of the Released Parties, and to indemnify and defend each of the Released Parties against, and to hold each of the Released Parties harmless of and from any Claims resulting from my acts or omissions during the Activities or while at any Site.

5. I have read and understand the policies and procedures specified in the Health and Safety Plan (HASP) for this Site. This HASP may include company-specific appendices developed by entities other than Anchor QEA.

The undersigned Participant acknowledges and agrees that he/she has carefully read this Release from Liability, Waiver of Claims, and Indemnification and fully understands all of its contents, and their legal effect, and agrees that this Release from Liability, Waiver of Claims, and Indemnification (of which I have been given a copy to keep, with any attachments) is contractually binding, and is being signed by the undersigned Participant of his/her own free will.

Signature: ______________________________ Date: ______________

Printed Name: ______________________ Email: ____________________

Street Address: ____

(street address — no PO Boxes)

City: ______________________ State: ________ Zip: ____________

Phone Number: ____

Emergency Contact Name: _____________________________________

Emergency Contact's Phone Number: ____________________________

Consent and Release for Publications of Photographs

I, the undersigned, hereby grant Anchor QEA permission to take photographs of me, and irrevocably consent to and authorize the use and reproduction by Anchor QEA, or anyone duly authorized by Anchor QEA, of any and all such photographs, for any legitimate purposes, including for advertising, trade, and editorial purposes, at any time in the future in all media now known or hereafter developed, throughout the world. I also consent to the use of my name in connection with such photographs.

I hereby release, indemnify, and hold harmless Anchor QEA and its agents, representatives, partners, contractors, consultants, or employees from any and all claims that may result at any time by reason of the use of my image and name, including, without limitation, claims of privacy. My heirs, executors, administrators, and assigns shall be bound by this consent and release. I am over the age of 18 years.

Signature: ______________________________ Date: ______________

Printed Name: ______________________

Site Emergency Procedures

Site Map

Figure A
General Site Location Overview

Emergency Contact Information

Table A
Site Emergency Form and Emergency Phone Numbers*

Category	Information	
Possible Chemicals of Concern	Coal tar pitch volatiles, PAHs, cyanide, metals, VOCs, and H_2S	
Minimum Level of Protection	Modified Level D	
Site(s) Location Address	7900 NW St. Helens Road, Portland, Oregon 97210	
Emergency Phone Numbers		
Ambulance	911	
Fire	911	
Police	911	
Poison Control	(800) 222-1222	
Client Contact	Bob Wyatt, NW Natural	Office: (503) 860-6451 Cell: (b) (6)
Project Manager (PM)	Ryan Barth, Anchor QEA	Office: (206) 903-3334 Cell: (b) (6)
Field Lead (FL)	Nik Bacher, Anchor QEA	Office: (206) 903-3376 Cell: (b) (6)
Site Safety and Health Officer (SSHO)	Tim Stone, Anchor QEA	Office: (503) 670-1108 Cell: (b) (6)
National Response Center	(800) 424-8802	
Oregon Emergency Response System	(800) 452-0311	
EPA Emergency Response Team, Region 10	(206) 553-4973	

Note:
* In the event of any emergency, contact the PM and FL.

Table B
Hospital Information

Category	Information
Hospital Name	Legacy Good Samaritan Hospital and Medical Center
Address	1015 NW 22nd Avenue
City, State	Portland, Oregon
Phone	(503) 413-7711
Emergency Phone	911

Hospital Route Map and Driving Directions

Figure B is a map of the route from the uplands project site (7900 NW St. Helens Road, Portland, Oregon, 97210) to the Legacy Good Samaritan Hospital and Medical Center. Directions are as follows (travel time is approximately 11 minutes):

1. Start out going northwest on NW Saint Helens Rd/US-30 W. (0.08 mi)
2. Make a left turn onto US-30 E. (4.4 mi)
3. Turn right onto NW Nicolai St. (0.07 mi)
4. Turn sharp left to stay on NW Nicolai St. (0.04 mi)
5. Take the 1st right onto NW 23rd Ave. (0.8 mi)
6. Turn left onto NW Lovejoy St. (0.10 mi)
7. Take the 1st left onto NW 22nd Ave.

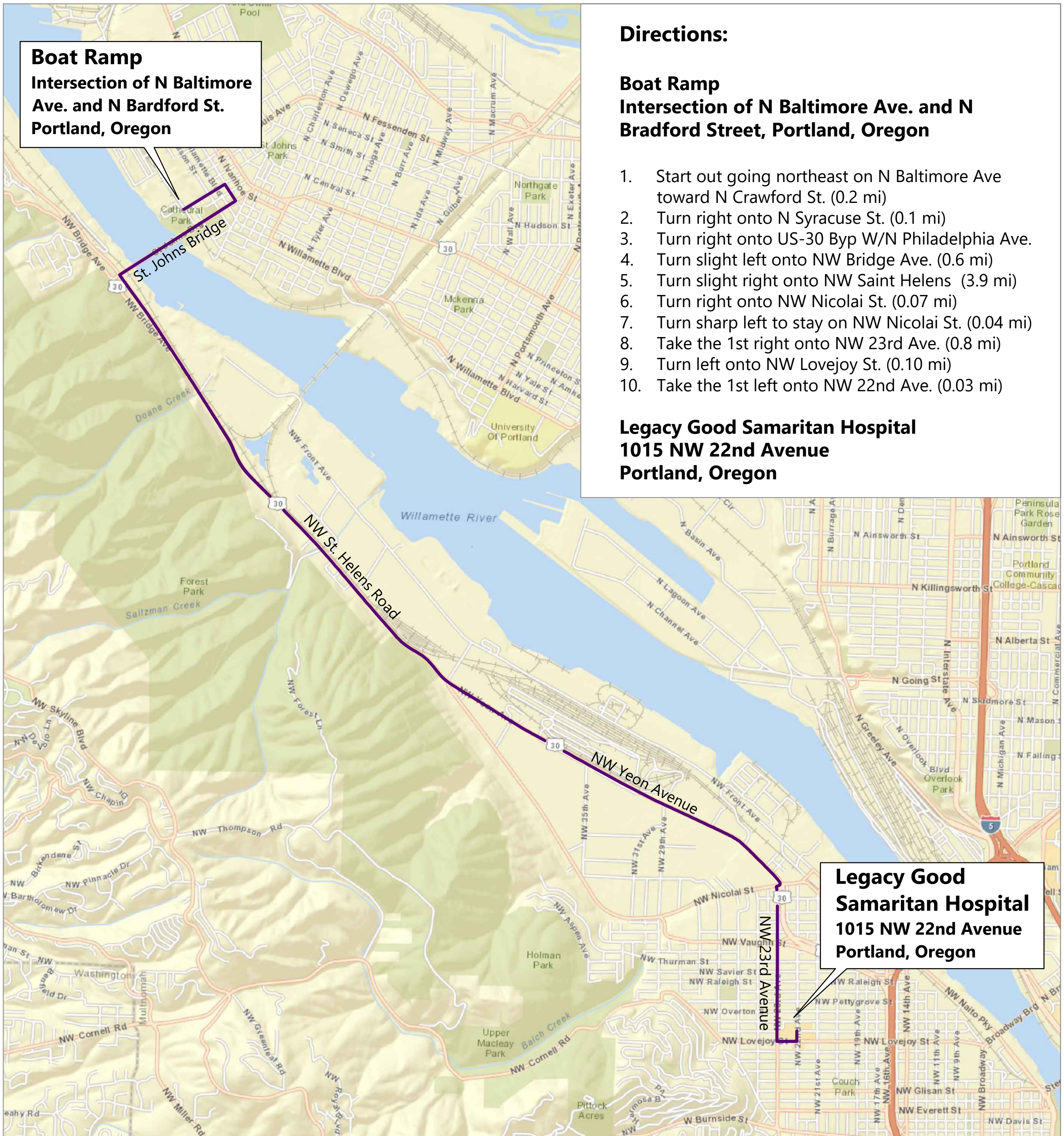
SOURCE: Esri/Delorme World Street Map.

Publish Date: 2018/10/30 2:32 PM | User: jbigsby
Filepath: K:\Projects\0029-NW Natural Gas Co\Gasco Site Remedy\0029-RP-002 (Rte Hsp-1).dwg Figure B

Figure B
Hospital Route Map from Uplands Site

Figure C is a map of the route from the boat launch area at Cathedral Park, St. Johns, Oregon, to the Legacy Good Samaritan Hospital and Medical Center. Directions are as follows (travel time is approximately 15 minutes):

1. Start out going northeast on N Baltimore Ave toward N Crawford St. (0.2 mi)
2. Turn right onto N Syracuse St. (0.1 mi)
3. Turn right onto US-30 Byp W/N Philadelphia Ave.
4. Turn slight left onto NW Bridge Ave. (0.6 mi)
5. Turn slight right onto NW Saint Helens (3.9 mi)
6. Turn right onto NW Nicolai St. (0.07 mi)
7. Turn sharp left to stay on NW Nicolai St. (0.04 mi)
8. Take the 1st right onto NW 23rd Ave. (0.8 mi)
9. Turn left onto NW Lovejoy St. (0.10 mi)
10. Take the 1st left onto NW 22nd Ave. (0.03 mi)



Directions:

Boat Ramp
Intersection of N Baltimore Ave. and N Bradford Street, Portland, Oregon

1. Start out going northeast on N Baltimore Ave toward N Crawford St. (0.2 mi)
2. Turn right onto N Syracuse St. (0.1 mi)
3. Turn right onto US-30 Byp W/N Philadelphia Ave.
4. Turn slight left onto NW Bridge Ave. (0.6 mi)
5. Turn slight right onto NW Saint Helens (3.9 mi)
6. Turn right onto NW Nicolai St. (0.07 mi)
7. Turn sharp left to stay on NW Nicolai St. (0.04 mi)
8. Take the 1st right onto NW 23rd Ave. (0.8 mi)
9. Turn left onto NW Lovejoy St. (0.10 mi)
10. Take the 1st left onto NW 22nd Ave. (0.03 mi)

Legacy Good Samaritan Hospital
1015 NW 22nd Avenue
Portland, Oregon

SOURCE: Esri/Delorme World Street Map.

0 0.75
Miles

Publish Date: 2018/11/08 2:56 PM | User: jbigsby
Filepath: K:\Projects\0029-NW Natural Gas Co\Gasco Site Remedy\0029-RP-003 (Rte Hsp-2).dwg Figure C

Figure C
Hospital Route Map from Boat Launch (Cathedral Park)

WorkCare Incident Intervention

Anchor QEA has an additional Incident Intervention resource from WorkCare to help answer questions, alleviate uncertainty and stress in a potential injury situation, and maintain the health and safety of our employees. Incident Intervention is an injury and illness management tool that provides employees with 24 hours a day/7 days a week (24/7) **immediate** telephone access to a member of WorkCare's clinical staff of nurses and physicians who intervene at the time of a workplace injury or illness. Contact information is provided below:

- **Access WorkCare 24/7 from anywhere using the toll-free number: 1-888-449-7787**

At the time of a workplace injury or illness, the employee, manager, or another employee at the scene notifies WorkCare using the toll-free number listed above. The caller provides information on the type of incident, possible cause, and the scope of the situation. With the details of the incident recorded, an experienced nurse or physician provides the following:

- Responsive evaluation of the incident
- Direction on the appropriate course of action
- Consultation with the employee's treating physician to design a quality care treatment plan that meets the needs of the employee and Anchor QEA

All employees are encouraged to use this service should a workplace injury or illness occur.

Key Safety Personnel

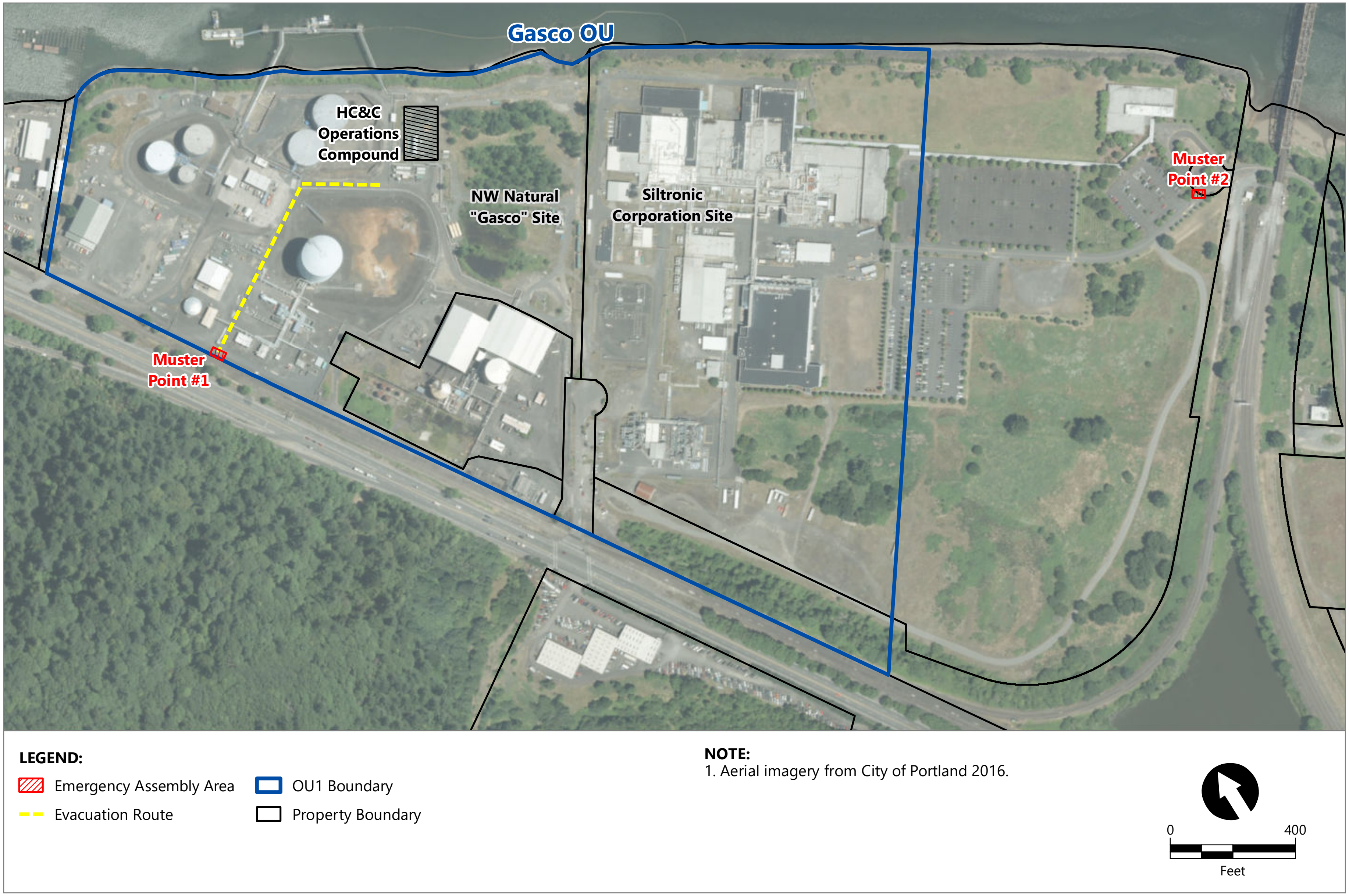
The following people share responsibility for health and safety at the site. See Section 4 of this Health and Safety Plan (HASP) for a description of the role and responsibility of each.

Client Contact: Bob Wyatt, NW Natural	Office: (503) 860-6451 Cell: (b) (6)
Project Manager (PM): Ryan Barth, Anchor QEA	Office: (206) 903-3334 Cell: (b) (6)
Field Lead (FL): Nik Bacher, Anchor QEA	Office: (206) 903-3376 Cell: (b) (6)
Site Safety and Health Officer (SSHO): Tim Stone, Anchor QEA	Office: (503) 670-1108 Cell: (b) (6)

Emergency Response Procedures

Site communications will be done with either a cell phone or a handheld two-way radio (two-way radios are kept on site and available for use by Anchor QEA staff), and service capabilities of cell phones at on-river locations will be checked daily. If there is an emergency that requires the site to be evacuated (e.g., river flood), the Field Lead (FL) or any other site personnel recognizing the condition will contact other field staff with phones or radios. In the event of an evacuation, personnel will meet at one of the emergency meeting locations depending on the circumstances:

1. **Gasco Uplands Work Area:** Meet at Muster Point 1, the site entrance near the Gasco guard shack, when on the upland portion of the site or when in the Koppers work area (see Figure D).
2. **Work on the Willamette River (On-Water Work Area):** Meet at Muster Point 2, the Cathedral Park Boat Ramp parking lot (see Figure C).



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ANCHOR QEA

Figure D
Emergency Evacuation Route Map and Emergency Assembly Area

Health and Safety Plan
Gasco Sediments Cleanup Action

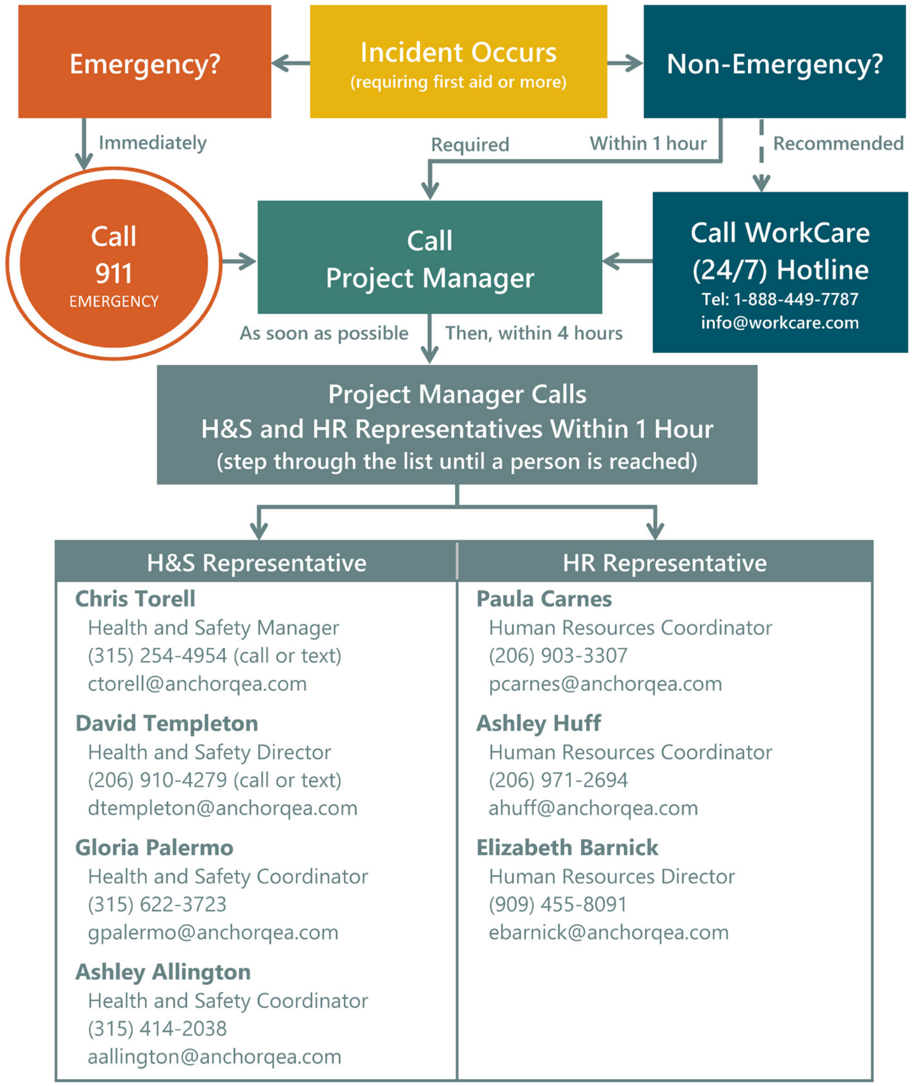
Personal Incident Response Procedures

In the event of an emergency, immediate action must be taken by the first person to recognize the event. Use the following steps as a guideline and refer to Figure E:

1. Survey the situation to verify that it is safe for you and the victim. Do not endanger your own life. Do not enter an area to rescue someone who has been overcome unless properly equipped and trained. Verify that all protocols are followed. If applicable, review Safety Data Sheets (SDS) to evaluate response actions for chemical exposures.
2. Call the appropriate emergency number (911, if available) or direct someone else to do this immediately (see Table A). Explain the physical injury, chemical exposure, fire, or release and location of the incident.
3. Have someone retrieve the nearest first aid kit (containing appropriate items for the particular work scope) and Automated External Defibrillator (AED), if available. Note: Only use an AED if you have been properly trained and are currently certified to do so.
4. Decontaminate the victim without delaying life-saving procedures (see Section 8).
5. Administer first aid and cardiopulmonary resuscitation (CPR), if properly trained, until emergency responders arrive.[1]
6. In the event that evacuation is required, the FL must perform a head count to verify that all Anchor QEA personnel are accounted for.
7. Notify the Field Lead (FL) and Project Manager (PM); the PM will notify the client contact. The PM will also contact the Corporate Health and Safety Manager (CHSM). The CHSM will facilitate the incident investigation. All client requirements pertinent to personal incident reporting will also be adhered to.
8. Complete the appropriate incident investigation reports.

[1] Personnel qualified and currently certified in basic first aid or CPR are protected under Good Samaritan policies as long as they only perform the basic tasks that they were taught. Do not perform first aid or CPR tasks if you have not been trained in first aid or CPR.

Figure E
Incident Flowchart



Non-Personal Incident Response Procedures

All incidents including, but not limited to, fire, explosion, property damage, or environmental release will be responded to in accordance with the site-specific HASP. In general, this includes securing the site appropriate to the incident, turning control over to the emergency responders, or securing the site and summoning appropriate remedial personnel or equipment. Anchor QEA will immediately notify the client of any major incident, fire, equipment or property damage, or environmental incident with a preliminary report. A full report will be provided within 72 hours.

Spills and Releases of Hazardous Materials

When required, notify the National Response Center and local state agencies. The following information should be provided to the National Response Center:

- Name and telephone number
- Name and address of incident location
- Time and type of incident
- Name and quantity of materials involved, if known
- Extent of injuries
- Possible hazards to human health or the environment outside the facility
- The emergency telephone number for the National Response Center is (800) 424-8802. If hazardous waste is released or produced through control of the incident, verify the following:
- Waste is collected and contained
- Containers of waste are removed or isolated from the immediate site of the emergency
- Treatment or storage of the recovered waste, contaminated soil or surface water, or any other material that results from the incident or its control is provided
- No waste that is incompatible with released material is treated or stored in the facility until cleanup procedures are completed
- Verify that all emergency equipment used is decontaminated, recharged, and fit for its intended use before operations are resumed.

Near-Miss Reporting

All near-miss incidents (i.e., those that could have reasonably led to an injury, environmental release, or other incident) must be reported to the FL and PM immediately, so action can be taken to verify that such conditions that led to the near-miss incident are readily corrected to prevent future occurrences.

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APPENDICES

ABBREVIATIONS

AED	automated external defibrillator
ANSI	American National Standards Institute
ASTM	ASTM International
CFR	Code of Federal Regulations
COC	chemical of concern
CPR	cardiopulmonary resuscitation
CRZ	Contamination Reduction Zone
dbA	A-weighted decibel
dB	decibel
DOT	U.S. Department of Transportation
DPT	direct push technology
EPA	U.S. Environmental Protection Agency
eV	electron volt
EZ	Exclusion Zone/Hot Zone
FL	Field Lead
GFCI	ground-fault circuit interrupter
H:V	horizontal to vertical
H_2S	hydrogen sulfide
HASP	Health and Safety Plan
HAZMAT	Hazardous Materials
HAZWOPER	Hazardous Waste Operations and Emergency Response
HC&C	hydraulic control and containment
HEPA	high-efficiency particulate air
ISEA	International Safety Equipment Association
JSA	Job Safety Analysis
Koppers	Koppers Industries, Inc.
kV	kilovolt
LEL	Lower Explosive Limit
LO/TO	lock out/tag out
mg/m^3	milligrams per cubic meter
MHR	maximum heart rate
N/A	not applicable
NIOSH	National Institute for Occupational Safety and Health
NPL	National Priority List
NRR	Noise Reduction Rating
O_2	oxygen

OSHA	Occupational Safety and Health Act or Administration
OV	organic vapor
OVM	organic vapor monitor
PAH	polycyclic aromatic hydrocarbon
PEL	Permissible Exposure Limit
PFD	personal flotation device
PID	photoionization detector
PM	Project Manager
PPE	personal protective equipment
ppm	parts per million
RCRA	Resource Conservation and Recovery Act
SDS	Safety Data Sheet
site	Gasco Sediments Site
SSHO	Site Safety and Health Officer
SZ	Support Zone/Clean Zone
TLV	Threshold Limit Value
TWA	time-weighted average
USCG	U.S. Coast Guard
UV	ultraviolet
VOC	volatile organic compound
WBGT	wet bulb globe temperature

1 Introduction

This Health and Safety Plan (HASP) was prepared on behalf of NW Natural and presents health and safety requirements and procedures that will be followed by Anchor QEA, LLC, personnel and at a minimum by Anchor QEA subcontractors during work activities at the Gasco Sediments Site (the site). This HASP was developed in accordance with Title 29 of the Code of Federal Regulations (CFR), Part 1910.120(b), and will be used in conjunction with Anchor QEA's Corporate Health and Safety Program. See Section 1.1 for HASP modification procedures.

The provisions of this HASP are mandatory for all Anchor QEA personnel assigned to the project. A copy of this HASP must be maintained on site and available for employee review at all times. Anchor QEA subcontractors are also expected to follow the provisions of this HASP unless they have their own HASP that covers their specific activities related to this project. Any subcontractor HASPs must include the requirements set forth in this HASP, at a minimum. All visitors to the work site must also abide by the requirements of this HASP and will attend a pre-work briefing where the contents of this HASP will be presented and discussed.

Personnel assigned to work at the project site will be required to read this plan and must sign the Health and Safety Plan Acknowledgement Form to confirm that they understand and agree to abide by the provisions of this HASP.

Subcontractors are ultimately responsible for the health and safety of their employees. Subcontractors may mandate health and safety protection measures for their employees beyond the minimum requirements specified in this HASP.

The objectives of this HASP are to identify potential physical, chemical, and biological hazards associated with field activities; establish safe working conditions and protective measures to control those hazards; define emergency procedures; and describe the responsibilities, training requirements, and medical monitoring requirements for site personnel.

This HASP prescribes the procedures that must be followed during specific site activities. Significant operational changes that could affect the health and safety of personnel, the community, or the environment will not be made without the prior approval of the Project Manager (PM) and the Site Safety and Health Officer (SSHO).

Issuance of this approved HASP documents that the workplace has been evaluated for hazards. A hazard assessment was performed, and the adequacy of the personal protective equipment (PPE) selected was evaluated as required by 29 CFR 1910.132(d) – Personal Protective Equipment, General Requirements (General Industry); 29 CFR 1910.134 – Respiratory Protection; 29 CFR 1926.28 – Personal Protective Equipment (Construction Industry); and 29 CFR 1926.55 – Gases, Vapors, Fumes, Dusts and Mist, and is duly noted by the signature(s) and date appearing on the certification page of this document.

1.1 Health and Safety Plan Modifications

This HASP will be modified by amendment, if necessary, to address changing field conditions or additional work tasks not already described in this document. Modifications will be proposed by the Field Lead (FL) using the Modification to Health and Safety Plan form included in Appendix A. Modifications will be reviewed by the SSHO or authorized representative and approved by the PM.

2 Site Description and Background Information

2.1 Site Description and Background Information

The Gasco site is a former gasification plant located at 7900 NW St. Helens Road, Portland, Oregon, 97210, and bounded on the northeast by the Willamette River at River Mile 6 and on the southwest by State Highway 30 (St. Helens Road). The site is within the initial study area of the Portland Harbor Superfund Site. It is adjacent to Siltronic and the U.S. Army Corps of Engineers U.S. Moorings facilities. The site is currently used as a storage facility for liquefied natural gas by NW Natural and as a bulk terminal for Pacific Terminals (tenant), and a significant portion of the site is undeveloped. The southeastern corner of the site is currently leased by Koppers Industries, Inc. (Koppers), for use as a storage and distribution facility for coal tar pitch and other related products. Koppers recently ceased operations and is planning to demolish the coal tar pitch buildings/structures/equipment.

Anchor QEA has constructed a hydraulic control and containment (HC&C) system in order to achieve groundwater source control at the site and prevent discharge of upland groundwater to the Willamette River. The HC&C system has been installed and is currently in operation and undergoing testing. The HC&C system consists of 21 extraction wells that pump contaminated groundwater to the site treatment system. The treated groundwater is discharged to the river under a National Pollutant Discharge Elimination System permit. Ongoing activities at the site include monitoring well, extraction well, observation well, and piezometer installation; operations and maintenance of the HC&C system; hydrologic data collection; dense nonaqueous phase liquid monitoring and removal; and demolition observation associated with Koppers building/structures/equipment.

3 Scope of Work

3.1 Project Scope of Work

This plan addresses health and safety issues associated with the following field tasks:

- Surface sediment collection from a boat
- Subsurface sediment core collection from a boat
- Subsurface boring collection and standard penetration test testing from a barge
- Cone penetrometer testing from a barge
- Onshore riverbank drilling using sonic methods
- Paired subsurface sediment and porewater sampling
- Gas ebullition monitoring
- Active sheen blossom sampling

4 Authority and Responsibilities of Key Personnel

This section describes the authority and responsibilities of key Anchor QEA project personnel. The names and contact information for the following key safety personnel are listed in the Site Emergency Procedures section at the beginning of this HASP. Should key site personnel change during the course of the project, a new list will be established and posted immediately at the site. The emergency phone number for the site is **911** and should be used for all medical, fire, and police emergencies.

4.1 Project Manager

The PM provides overall direction for the project. The PM is responsible for ensuring that the project meets the client's objectives in a safe and timely manner. The PM is responsible for providing qualified staff for the project and adequate resources and budget for the health and safety staff to carry out their responsibilities during the field work. The PM will be in regular contact with the FL and SSHO to ensure that appropriate health and safety procedures are implemented into each project task.

The PM has authority to direct response operations; the PM assumes total control over project activities but may assign responsibility for aspects of the project to others. In addition, the PM performs the following tasks:

- Oversees the preparation and organization of background review of the project, the Scope of Work, and the field team
- Ensures that the team obtains permission for site access and coordinates activities with appropriate officials
- Briefs the FL and field personnel on specific assignments
- Together with the FL, sees that health and safety requirements are met
- Consults with the SSHO regarding unsafe conditions, incidents, or changes in site conditions or the Scope of Work

4.2 Field Lead

The FL reports to the PM, has authority to direct response operations, and assumes control over on-site activities. The FL will direct field activities, will coordinate the technical and health and safety components of the field program, and is responsible in general for enforcing this site-specific HASP and Corporate Health and Safety Program requirements. The FL will be the primary point of contact for all field personnel and visitors and has direct responsibility for implementation and administration of this HASP. The FL and any other member of the field team have **STOP WORK AUTHORITY**—the authority to stop or suspend work in the event of an emergency, if conditions arise that pose an unacceptable health and safety risk to the field team or environment, or if conditions arise that warrant modifications to this HASP. It is critical that both the FL and PM communicate regularly to proactively identify and address any safety-related concerns that may arise. The following include, but are not necessarily limited to, the functions of the FL related to this HASP:

- Conduct and document daily safety meetings or designate an alternate FL in his or her absence.
- Execute the Scope of Work and schedule.
- Conduct periodic field health and safety inspections to ensure compliance with this HASP.
- Oversee implementation of safety procedures.
- Implement site personnel protection levels.
- Enforce site control measures to help ensure that only authorized personnel are allowed on site.
- Notify, when necessary, local public emergency officials (all personnel on site may conduct this task as needed).
- Follow-up on incident reports to the PM.
- Periodically inspect protective clothing and equipment for adequacy and safety compliance.
- Ensure that protective clothing and equipment are properly stored and maintained.
- Perform or oversee air monitoring (if required) in accordance with this HASP.
- Maintain and oversee operation of monitoring equipment and interpretation of data from the monitoring equipment.
- Monitor site personnel for signs of stress, including heat stress, overexertion, cold exposure, and fatigue.
- Require participants to use the "buddy" system in performing tasks.
- Provide (via implementation of this HASP) emergency procedures, evacuation routes, and telephone numbers for the local hospital, poison control center, fire department, and police department.
- Communicate incidents promptly to the PM.
- Maintain communication with the SSHO regarding on-site activities.
- If applicable, ensure that decontamination and disposal procedures are followed.
- Maintain the availability of required safety equipment.
- Advise appropriate health services and medical personnel of potential exposures.
- Notify emergency response personnel in the event of an emergency and coordinate emergency medical care.

The FL will record health-and-safety-related details of the project in the field logbook. At a minimum, each day's entries must include the following information:

- Project name or location
- Names of all on-site personnel

- Level of PPE worn and any other specifics regarding PPE
- Weather conditions
- Type of field work being performed

The FL will have completed the required Occupational Safety and Health Administration (OSHA) 40-hour Hazardous Waste Operations and Emergency Response (HAZWOPER) training and annual updates, the 8-hour Supervisor training, medical monitoring clearance, and current first aid and cardiopulmonary resuscitation (CPR) training. Other certifications or training may be stipulated based on client or site requirements.

4.3 Site Safety and Health Officer

The SSHO (or designee) will be responsible for managing on-site health and safety activities and will provide support to the PM and FL on health and safety-related issues. The following are specific duties of the SSHO:

- Provide technical input into the design and implementation of this HASP.
- Advise on the potential for occupational exposure to project hazards, along with appropriate methods and/or controls to eliminate site hazards.
- Ensure that a hazard assessment has been performed and that the adequacy of the PPE selected was evaluated as required by 29 CFR 1910.132(d), 29 CFR 1910.134, 29 CFR 1926.25, and 29 CFR 1926.55, and is duly noted by the signatures and date appearing on the Certification Page of this document.
- Consult with the FL on matters relating to suspending site activities in the event of an emergency.
- Verify that all on-site Anchor QEA personnel and subcontractors have read and signed the HASP Acknowledgement Form.
- Verify that corrective actions resulting from deficiencies identified by audit and observations are implemented and effective.

The SSHO or designee will have completed the required OSHA 40-hour HAZWOPER training and annual updates, as well as the 8-hour Supervisor training, and will have medical monitoring clearance. In addition, the SSHO or designee will have current training in first aid and CPR.

4.4 Project Field Team

All project field team members will attend a project-specific meeting conducted by the FL concerning safety issues and project work task review before beginning work on site. All field team members, including subcontractors, must be familiar with and comply with this HASP. The field team has the responsibility to immediately report any potentially unsafe or hazardous conditions to the FL, and all members of the field team have **STOP WORK AUTHORITY**—the authority to stop or suspend work if conditions arise that pose an unacceptable health and safety risk to the field team or environment, or if conditions arise that warrant modifications to this HASP. It is critical that all field team members proactively communicate with the FL to identify potential unsafe conditions. The field team reports to the FL for on-site activities and is responsible for the following:

- Reviewing and maintaining a working knowledge of this HASP
- Safe completion of on-site tasks required to fulfill the Scope of Work
- Compliance with the HASP
- Attendance and participation in daily safety meetings
- Notification to the FL of existing or potential safety conditions at the site
- Reporting all incidents to the FL
- Demonstrating safety and health-conscious conduct

Per OSHA 1910.120(e)(3)(i),[2] newly assigned HAZWOPER 40-hour trained field team members must have at least 3 days of field work supervised by an experienced FL (preferably an individual with HAZWOPER Supervisor training). It is the responsibility of the PM to identify such "short service" personnel and ensure that their supervised field experience occurs (or has occurred) and is documented in the project field notes and on the Daily Safety Briefing form (Appendix A).

[2] "General site workers (such as equipment operators, general laborers and supervisory personnel) engaged in hazardous substance removal or other activities which expose or potentially expose workers to hazardous substances and health hazards shall receive a minimum of 40 hours of instruction off the site, and a minimum of three days actual field experience under the direct supervision of a trained experienced supervisor."

5 Project-Specific Requirements

This section provides activity-specific levels of protection and air monitoring requirements to be used on this site based on the Scope of Work and the chemicals of concern (COCs).

5.1 Activity-Specific Level of Protection Requirements

Refer to Section 10 for general requirements for PPE. Level D is the minimum acceptable level for most sites. An upgrade to Modified Level D occurs when there is a possibility that contaminated media can come in contact with the skin or work uniform. An upgrade to Level C occurs when there is a potential for exposure to airborne COCs (i.e., if the results of air monitoring reveal that action levels have been exceeded). Hearing protection must be worn when there are high noise levels. Site personnel must maintain proficiency in the use and care of PPE that is to be worn.

Table 5-1 describes the specific means of protection needed for each identified work activity.

5.2 Project Air Monitoring Requirements

Refer to Section 11 of this plan for general requirements for air monitoring at the project site, including information on air monitoring equipment. Upgrade from Level D and/or Modified Level D to Level C when the results of air monitoring reveals that action levels have been exceeded.

Table 5-2 describes the specific air monitoring required for each identified work activity.

Table 5-1
Project Job Tasks and Required PPE

Job Tasks		PPE Requirements
• Field activities on shore or on vessel with no anticipated direct contact with soils, sediments, sheens, or decontamination chemicals, including deploying instrumentation	☒	Standard work uniform/coveralls
	☒	Work boots with safety toe conforming to ASTM International (ASTM) F2412-2413 (above ankle height with outsoles designed to prevent or resist punctures, slips, and falls; defined heels; and composite or steel toes)
	☒	Traffic safety vest conforming to American National Standards Institute (ANSI) 107 (e.g., Class I or II) for onshore work.
	☐	Chemical-resistant clothing check appropriate garments: ☐ One-piece coverall ☐ Hooded one- or two-piece chemical splash suit ☐ Disposable chemical coveralls ☐ Chemical-resistant hood and apron ☐ Bib-style overalls and jacket with hood **Fabric Type**: Tyvek NOTE: Thick rain pants and coveralls may be substituted for coated Tyvek if sediments are not obviously contaminated with polycyclic aromatic hydrocarbons (PAHs) or related petroleum products. Rain slickers cannot be effectively decontaminated of tar/petroleum contamination.
	☐	Disposable inner gloves (latex or equivalent "surgical")
	☐	Disposable chemical-resistant outer gloves **Material Type**: Nitrile
	☐	Chemical-resistant boots with safety toe conforming to ASTM F2412-05/ASTM F2413-05 or disposable boot covers for safety toe/work boots **Material Type**: Rubber or leather
	☐	Puncture-resistant shanks in safety shoes conforming to ASTM F2412-05/ASTM F2413-05
	☐	Metatarsal guards conforming to ASTM F2412-05/ASTM F2413-05
	☐	Sleeves to be duct-taped over gloves and pants to be duct-taped over boots
	☐	Splash-proof safety goggles
	☒	Safety glasses conforming to ANSI/International Safety Equipment Association (ISEA) Z87.1 with permanently installed side shields
	☒	Hard hat (if overhead hazards exist) conforming to ANSI Z89
	☐	Hard hat with face shield
	☒	Hearing protectors (**REQUIRED** if site noise levels are greater than 85 decibels [dB] based on an 8-hour time-weighted average [TWA]). **Type**: Foam
	☐	Two-way radio communication (intrinsically safe, if explosive atmosphere is a potential)

Job Tasks		PPE Requirements
	☒	N95 dust mask (if forest fires are regionally present; contact SSHO)
	☒	High-visibility, U.S. Coast Guard (USCG)-approved personal flotation device (PFD) (if working on any water vessel or without fall protection within 10 feet of water)
	☒	USCG-approved float coat and bib-overalls (e.g., full two-piece "Mustang" survival suit or similar) or one-piece survival suit if combined air and water temperature is below 90°F
	☐	Half-face air-purifying respirator (OSHA/National Institute for Occupational Safety and Health [NIOSH]-approved)
	☐	Full-face air-purifying respirator (OSHA/NIOSH-approved)
	☐	**Type of Cartridges to be Used**: ☐ **OV or** ☐ **OV/high-efficiency particulate air (HEPA) (if samples are dry)**
• Sampling or investigation activities on land or on vessel (i.e., drilling/coring) with reasonably anticipated contact with soils, sediments, or sheens containing COCs or with decontamination chemicals	☒	Standard work uniform/coveralls
	☒	Work boots with safety toe conforming to ASTM F2412-2413 (above ankle height with outsoles designed to prevent or resist punctures, slips, and falls; defined heels; and composite or steel toes)
	☒	Traffic safety vest conforming to ANSI 107 (e.g., Class I or II) for onshore work.
	☒	Chemical-resistant clothing <u>check appropriate garments</u>: ☐ One-piece coverall ☐ Hooded one- or two-piece chemical splash suit ☒ Disposable chemical coveralls ☐ Chemical-resistant hood and apron ☐ Bib-style overalls and jacket with hood **Fabric Type**: Tyvek NOTE: Thick rain pants and coveralls may be substituted for coated Tyvek if sediments are not obviously contaminated with PAHs or related petroleum products. Rain slickers cannot be effectively decontaminated of tar/petroleum contamination.
	☒	Disposable inner gloves (latex or equivalent "surgical")
	☒	Disposable chemical-resistant outer gloves **Material Type**: Nitrile
	☐	Chemical-resistant boots with safety toe and steel shank conforming to ASTM F2412-05/ASTM F2413-05 or disposable boot covers for safety toe/work boots **Material Type**: Rubber or leather
	☐	Puncture-resistant shanks in safety shoes conforming to ASTM F2412-05/ASTM F2413-05
	☐	Metatarsal guards conforming to ASTM F2412-05/ASTM F2413-05

Job Tasks		PPE Requirements
	☐	Sleeves to be duct-taped over gloves and pants to be duct-taped over boots
	☐	Splash-proof safety goggles
	☒	Safety glasses conforming to ANSI/ISEA Z87.1 with permanently installed side shields
	☒	Hard hat (if overhead hazards exist) conforming to ANSI Z89
	☐	Hard hat with face shield
	☒	Hearing protectors (**REQUIRED** if site noise levels are greater than 85 dB based on an 8-hour TWA). **Type:** Foam
	☐	Two-way radio communication (intrinsically safe, if explosive atmosphere is a potential)
	☒	N95 dust mask (if forest fires are regionally present; contact SSHO)
	☒	High-visibility, USCG-approved PFD (if working on any water vessel or without fall protection within 10 feet of water)
	☒	USCG-approved float coat and bib-overalls (e.g., full two-piece “Mustang” survival suit or similar) or one-piece survival suit if combined air and water temperature is below 90°F
	☐	Half-face air-purifying respirator (OSHA/NIOSH-approved)
	☐	Full-face air-purifying respirator (OSHA/NIOSH-approved)
	☐	**Type of Cartridges to be Used:** ☐ **OV or** ☐ **OV/HEPA (if samples are dry)**

Table 5-2
Project Air Monitoring Requirements

Instrument*	Job Tasks/Functions	Measurement	Monitoring Schedule[3]	Actions[1]
PID (10.6*eV lamp) – Measures Total OVs	Conduct air monitoring for VOCs during activities where contaminated media are present and/or when potentially contaminated media is disturbed. Make sure that a background reading is taken before the start of activities and periodically thereafter.	0 to 1 ppm sustained above background in breathing zone	Periodically (every 15-30 minutes)	Acceptable; continue work.
		>1 to 10 ppm sustained above background	Periodically (every 15 minutes)	Stop work if sustained readings for longer than 2 minutes[2]. Institute engineering controls. If concentrations decrease to below 1 ppm above background, continue work. If concentrations above 1 ppm persist, upgrade to Level C protection[4]. Monitor for benzene and vinyl chloride using colorimetric detector tubes. Continue working with respiratory protection if colorimetric detector tubes indicate less than 1 ppm for benzene and/or vinyl chloride. Leave the work area if colorimetric tubes indicate > 1 ppm in the employee's breathing zone; contact PM for further guidance.
		>10 ppm sustained above background in breathing zone		Stop work required[2]. Leave work area and contact PM and CHSM for guidance.

Instrument*	Job Tasks/Functions	Measurement	Monitoring Schedule[3]	Actions[1]
Dust Monitor (respirable fraction)	Conduct monitoring when dusty conditions are encountered in areas that contain dry, potentially contaminated media and/or when dry, potentially contaminated media is disturbed. Monitor in employee breathing zones and general areas. Determine if potentially contaminated materials are migrating off site. Monitor in the workers' breathing zone. Dust concentration action levels are based on downwind minus upwind measurements.	< 0.1 mg/m^{3}sustained above background in breathing zone	Initially and every 15 minutes while conditions persist	Acceptable; continue work.
		≥0.1 mg/m^3, < 1.0 mg/m^{3}sustained above background in breathing zone	Continuously	Initiate wetting work area to control dusts.
		≥ 1.0 mg/m^3, ≤ 5.0 mg/m^3 sustained above background in breathing zone	Continuously	Upgrade to Level C[4].
		≥ 5mg/m^3 sustained above background in breathing zone	Continuous for one minute	Stop work required.[4] Leave work area and contact PM and CHSM for guidance.
Hydrogen Cyanide Monitor	Conduct air monitoring for hydrogen cyanide during activities where contaminated media are present and/or when potentially contaminated media is disturbed. Monitor in the workers' breathing zone.	0 to 4 ppm sustained hydrogen cyanide	Periodically (every 15 minutes)	Acceptable; continue work.
		> 4 ppm sustained hydrogen cyanide	Continuously	Stop work required.[2] Leave work area and contact PM and SSHO for guidance.

Notes:

* Instruments must be calibrated according to manufacturer's recommendations.

1. For VOCs, a sustained reading for greater than 2 minutes in excess of the action level will trigger a protective measure.
2. Contact with the SSHO and PM must be made prior to continuance of work. A hazard review must be conducted before proceeding with work. Corrective actions may include temporary work stoppage to allow vapors to dissipate, and then returning to work if air monitoring data permits.
3. Monitoring frequency is from the beginning of each task and at specified intervals thereafter, or when detectable contamination is encountered (as indicated by strong, sustained odor, visual evidence of product, or petroleum-discolored soils).
4. Contact the PM for quantitative respiratory protection fit testing and air purifying cartridge change-out requirements.

6 Risk Analysis and Control

The following sections discuss the potential health and safety hazards associated with the field tasks described in the Scope of Work. Controls of these hazards are addressed through the mechanical and physical control measures, use of PPE, monitoring, training, decontamination, emergency response, and safety procedures.

Significant changes in the Scope of Work covered by this HASP must be communicated to the PM and SSHO, and a modification to this HASP must be created as needed (see Section 1.1). Any task conducted beyond those identified in the Scope of Work and this HASP must be evaluated using the Job Safety Analysis (JSA) process prior to conducting the work.

6.1 Job Safety Analysis

Anchor QEA work tasks have been evaluated for their hazards, and JSA documents have been developed that detail the chemical, physical, and biological hazards associated with these tasks, along with the control measures (e.g., engineering controls, administrative controls, and/or PPE) that will be used to ensure that these tasks are conducted in a safe manner.

The PM and FL are responsible for identifying work tasks and project site conditions that are beyond the previously developed JSA documents and for communicating such information to the SSHO. The SSHO will provide support, as needed, to the PM and/or the FL, who will have primary responsibility to develop project-specific JSAs.

The contents of the JSA documents shall be communicated to project personnel during the site orientation meeting and during daily safety meetings when conducting work where the specific JSAs are applicable.

JSA documents applicable to this project are located in Appendix B and include the following field tasks:

- Field activities (AQJSA001)
- Sediment sampling (AQJSA002), which covers the following tasks:
  - Surface sediment sampling by a hydraulic or gravity-driven Van Veen or grab sampling device
  - Subsurface sediment coring using vibracore methods
  - Porewater sampling
- Drilling (AQJSA005)
- Active sheen blossom sampling (AQJSA007)
- Boating activities (AQJSA003)
- Decontamination activities (AQJSA004)
- Motor vehicle operation (AQJSA006)

- Sample and laboratory glassware handling (AQJSA009)
- Investigation-derived waste management (AQJSA010)

6.1.1 Augmented Job Safety Analysis Process

If significant work tasks are identified during the course of the project that were not previously addressed in the JSA documentation supplied in Appendix B, then a task-specific JSA document must be developed at the project site prior to conducting the work. The PM and/or FL shall develop this document(s) with input from the SSHO, as needed, and this HASP will be modified to include the JSA document (see Section 1.1 for HASP modification procedures). Project personnel shall be trained on the contents of the developed task-specific JSA prior to its implementation. A copy of the task-specific JSA form used in this process is supplied in Appendix B of this HASP.

6.2 Exposure Routes

Possible routes of exposure to the chemicals potentially encountered on this project include inhalation, dermal contact, and ingestion of dust, mist, gas, vapor, or liquid. Exposure will be minimized by using safe work practices and by wearing the appropriate PPE. A further discussion of PPE requirements is presented in Section 10.

6.2.1 Inhalation

Inhalation of particulates, dust, mist, gas, or vapor during field activities is possible. Whenever possible, work activities will be oriented so that personnel are upwind of the sampling location. An organic vapor monitor (OVM) may be used to monitor ambient air and the breathing zone within the work area for organic compounds. Section 5.2 describes potential OVM action levels and response procedures.

6.2.2 Dermal Contact

Dermal contact with potentially contaminated soil, sediment, or water during field activities is possible. Direct contact will be minimized by using appropriate PPE and decontamination procedures.

6.2.3 Ingestion

Direct ingestion of contaminants can occur by inhaling airborne dust, mist, or vapors, or by swallowing contaminants trapped in the upper respiratory tract. Indirect ingestion can occur by introducing the contaminants into the mouth by way of food, tobacco, fingers, or other carriers. Although ingestion of contaminants can occur, proper hygiene, decontamination, and contamination reduction procedures should reduce the probability of this route of exposure.

6.3 Chemicals of Concern Profile

Table 6-1 provides a summary profile for the COCs for this project. As available, this profile is based on recent site history and site characterization information. For more detailed and specific information, always refer to the Safety Data Sheet (SDS) or equivalent information for the chemical (see Appendix C).

Table 6-1
Chemicals of Concern Profile

Chemical	Exposure Routes	Symptoms	Target Organs	OSHA PEL	Odor Threshold (ppm)	LEL (%)	Ionization Potential (eV)
Coal tar pitch volatiles (as benzo(a)pyrene)	Inhalation, skin and/or eye contact	Dermatitis, bronchitis; potential occupational carcinogen	Respiratory system, skin, bladder, kidneys	0.2 mg/m^3	Various	Various	Various
VOCs (as benzene)	Inhalation, skin absorption, ingestion, skin and/or eye contact	Irritation eyes, skin, nose, respiratory system; dizziness; headache, nausea, staggered gait; anorexia, lassitude (weakness, exhaustion); dermatitis; bone marrow depression; potential occupational carcinogen	Eyes, skin, respiratory system, blood, central nervous system, bone marrow	1 ppm	8.65	1.2	9.24
Metals (as lead)	Inhalation, ingestion, skin and/or eye contact	Lassitude (weakness, exhaustion), insomnia; facial pallor; anorexia, weight loss, malnutrition; constipation, abdominal pain, colic; anemia; gingival lead line; tremor; paralysis wrist, ankles; encephalopathy; kidney disease; irritation eyes; hypertension	Eyes, gastrointestinal tract, central nervous system, kidneys, blood, gingival tissue	0.05 mg/m^3	N/A	N/A	N/A
Cyanide (as hydrogen cyanide)	Inhalation, skin absorption, ingestion, skin and/or eye contact	Asphyxia; lassitude (weakness, exhaustion), headache, confusion; nausea, vomiting; increased rate and depth of respiration or respiration slow and gasping; thyroid, blood changes	Central nervous system, cardiovascular system, thyroid, blood	10 ppm	0.603	5.6	13.60
Hydrogen sulfide	Inhalation, skin and/or eye contact	Irritation eyes, respiratory system; apnea, coma, convulsions; conjunctivitis, eye pain, lacrimation (discharge of tears), photophobia (abnormal visual intolerance to light), corneal vesiculation; dizziness, headache, lassitude (weakness, exhaustion), irritability, insomnia; gastrointestinal disturbance; liquid: frostbite	Eyes, respiratory system, central nervous system	20 ppm	0.01 to 1.5	4.0	10.46

Notes:
Sources: https://www.cdc.gov/niosh/npg/default.html https://multimedia.3m.com/mws/media/639110O/3m-respirator-selection-guide.pdf
https://www.osha.gov/SLTC/hydrogensulfide/hazards.html

7 Site Control and Communications

The primary purposes for site controls are to establish the hazardous area perimeter, reduce migration of contaminants into clean areas, and prevent unauthorized access or exposure to hazardous materials by site personnel and the public. Site control is especially important in emergency situations.

7.1 General Site Control Safety Procedures

The following standard safe work practices apply to all Anchor QEA site personnel and subcontractors and shall be discussed in the safety briefing prior to initiating work on the site:

- Eating, drinking, chewing gum or tobacco, and smoking are prohibited on site except in designated areas.
- Hands and faces must be washed upon leaving the work area and before eating, drinking, chewing gum or tobacco, and smoking.
- A buddy system will be used. Radio, cell phone, or hand signals will be established to maintain communication.
- During site operations, each worker will consider himself/herself as a safety backup to his/her partner.
- Visual contact will be maintained between buddies on site when performing potentially hazardous duties.
- No personnel will be admitted to the site without the proper safety equipment, training, and (if required) medical surveillance certification.
- All personnel must comply with established safety procedures. Any staff member who does not comply with safety policy as established in this HASP may be subject to corrective action, potentially including but not limited to, being reprimanded or immediate dismissal.
- Proper decontamination procedures must be followed before leaving a contaminated work area.

7.2 Work Area Access Control

If work is performed in public areas, the following precautions shall be taken to protect both the site personnel and the public. Access control to the work area will be accomplished using a combination of the following devices and/or methods:

- Fences and/or barricades
- Traffic control devices and/or use of flaggers
- Caution tape
- Other methods to keep the site secure and provide a visual barrier to help keep unauthorized personnel from entering the site and active work areas

7.3 Hazardous Waste Site Work Control Procedures

To prevent contamination from migrating from personnel and equipment, work areas will be clearly specified as an Exclusion Zone/Hot Zone (EZ), Contamination Reduction Zone (CRZ), or Support Zone/Clean Zone (SZ) prior to beginning operations. Each work area will be clearly identified using signs or physical barriers. At the end of each workday, the site should be secured and/or guarded to prevent unauthorized entry.

Site work zones will include:

- **Exclusion Zone/Hot Zone (EZ).** The EZ will be the "hot zone" or contaminated area inside the site perimeter (or sample collection area of boat). The EZ is the defined area where potential respiratory and/or health hazards exist. All personnel entering the EZ must use the required PPE, as set forth in this HASP, and meet the appropriate training and medical clearance. Entry to and exit from this zone will be made through a designated point. Appropriate warning signs to identify the EZ should be posted (e.g., DANGER, AUTHORIZED PERSONNEL ONLY, PROTECTIVE EQUIPMENT REQUIRED BEYOND THIS POINT). Personnel and equipment decontamination must be performed upon exiting the EZ.
- **Contamination Reduction Zone (CRZ).** The CRZ, also known as the "warm zone," is a transitional zone between the EZ and the SZ (also known as the "cold zone" or "clean zone"). The CRZ provides a location for removal and decontamination of PPE and tools leaving the EZ. A separate decontamination area will be established for heavy equipment. All personnel and equipment must exit via the CRZ. If the CRZ is compromised at any time, a new CRZ will be established.
- **Support Zone/Clean Zone (SZ).** This uncontaminated zone will be the area outside the EZ and CRZ and within the geographic perimeters of the site (including boat and processing areas). The SZ is used for support personnel; staging materials; parking vehicles; office, laboratory, and sanitation facilities; and receiving deliveries. Personnel entering this zone may include delivery personnel, visitors, security guards, and others who will not necessarily be permitted in the EZ or CRZ.

A log of all personnel visiting, entering, or working on the site shall be maintained by the FL. No visitor will be allowed in the EZ without showing proof of training and medical certification, per 29 CFR 1910.120(e),(f) (and 29 CFR 1926.1101(k)(9),(m) if appropriate). Visitors will attend a site orientation given by the FL and sign the HASP.

7.4 Site-Specific Work Zone Requirements

This section contains guidelines for maintaining safe conditions when working from a boat or at an excavation site.

7.4.1 Sediment Sampling Work Zones

This subsection contains guidelines concerning health and safety aboard marine sampling vessels. The vessel captain, onshore coring operator, and the FL will delineate the boundaries of the work zones aboard the vessel and will inform the field team of the arrangement. The purpose of the zones is to limit the migration of sample material out of the zones and to restrict access to active work areas.

Two work zones will be observed aboard the vessel. One will encompass the "moonhole" of the vessel where the samplers will be deployed and recovered. Only the coring team may enter this zone unless assistance is required by other personnel. The second work zone will be a sample processing area on the vessel. The contractor team will deliver sediment core tubes to this zone and open them. Anchor QEA personnel will log and process the sediment cores either on the boat or on shore.

Both the collection and processing areas on the vessel and onshore will have a SZ outside the CRZ to stage clean equipment, don PPE, take rest breaks, or perform any other site activities that do not involve potentially contaminated materials.

7.4.1.1 Vessel Decontamination Area

A station will be set up for decontaminating sample processing equipment and personnel gear such as boots or PPE. The station will have the buckets, brushes, soapy water, rinse water, or wipes necessary to perform decontamination operations. Plastic bags will be provided for expendable and disposable materials. Decontamination fluids will be stored in labeled, sealable containers and will be properly disposed of.

7.4.1.2 Access Control

Security and control of access to the sampling vessel and onshore area will be the responsibility of the captain and FL. Additional security measures may be placed into effect by the client, or as required by national security threat levels determined by the federal government. Access to the vessel and onshore areas will only be granted to necessary project personnel and authorized visitors. Any security or access control problems will be reported to the client or appropriate authorities.

7.4.1.3 Safety Equipment

In addition to PPE that will be worn by shipboard personnel, basic emergency and first aid equipment will also be provided. Equipment will include:

- U.S. Coast Guard (USCG)-approved personal flotation devices (PFDs)
- First aid kit adequate for the number of personnel
- Emergency eyewash

Anchor QEA and/or subconsultants will provide this equipment, which must be at the location(s) where field activities are being performed. Equipment will be checked daily to ensure its readiness for use.

7.5 Field Communications

Communications between all Anchor QEA employees and subcontractors at the work site can be verbal and/or non-verbal. Verbal communication can be affected by the on-site background noise and various PPE. See Table 7-1 for a list of the types of communication methods and equipment to use, depending on site conditions. Communication equipment must be checked daily to ensure proper operation. All project personnel must be initially briefed on the communication methods prior to starting work; communication methods should be reviewed in daily safety meetings.

Table 7-1
Field Communication Methods

Type of Communication	Communication Device	Signal
Emergency notification	On-site telephone or cellular telephone	Initiate phone call using applicable emergency numbers
Emergency notification among site personnel	Two-way radio	Initiate radio communication with Code Red message
Hailing site personnel for non-emergency	Compressed air horn	One long blast, one short blast
Hailing site personnel for emergency evacuation	Compressed air horn	Three long, continuous blasts
Hailing site personnel for distress, need help	Visual	Arms waved in circle over head
Hailing site personnel for emergency evacuation	Visual	Arms waved in criss-cross over head
Contaminated air/strong odor	Visual	Hands clutching throat
Break, lunch, end of day	Visual	Two hands together, break apart

8 Decontamination Procedures and Practices

8.1 Minimization of Contamination

The following measures will be observed to prevent or minimize exposure to potentially contaminated materials:

Personnel

- Do not walk through spilled materials.
- Do not handle, touch, or smell sample media directly.
- Make sure PPE has no cuts or tears prior to use.
- Protect and cover any skin injuries.
- Stay upwind of airborne dusts and vapors.
- Do not eat, drink, chew tobacco, or smoke in the work zones.

Sampling Equipment and Vehicles/Vessels

- Use care to avoid getting sampled media on the outside of sample containers.
- If necessary, bag sample containers before filling with sampled media.
- Place clean equipment on a plastic sheet to avoid direct contact with contaminated media.
- Keep contaminated equipment and tools separate from clean equipment and tools.
- Fill sample containers over a plastic tub to contain spillage.
- Clean up spilled material immediately to avoid tracking around the vehicle/vessel.

8.2 Decontamination Equipment

All vehicles, vessels, and equipment that have entered potentially contaminated areas will be visually inspected and, if necessary, decontaminated prior to leaving the area. If the level of vehicle contamination is low, decontamination may be limited to rinsing tires and wheel wells with an appropriate detergent and water. If the vehicle is significantly contaminated, steam cleaning or pressure washing may be required. Tools will be cleaned in the same manner. Rinsate from all decontamination activities will be collected for proper disposal. Decontamination of equipment and tools will take place within the CRZ.

The following supplies will be available to perform decontamination activities:

- Wash and rinse buckets
- Tap water and phosphate-free detergent
- Scrub brushes
- Distilled/deionized water
- Deck pump with pressurized freshwater hose (aboard the vessel)
- Pressure washer/steam cleaner, if appropriate

- Paper towels and plastic garbage bags

8.3 Personnel Decontamination

The FL will ensure that all site personnel are familiar with personnel decontamination procedures as listed below. All personnel wearing PPE in a work area (EZ) must undergo decontamination prior to entering the SZ. Personnel will perform the following decontamination procedures:

- Wash and rinse outer gloves and boots in portable buckets to remove gross contamination.
- If suit is heavily soiled, rinse it off.
- Remove outer gloves; inspect and discard if damaged. Leave inner gloves on. Personnel will remove their outer garment and gloves, dispose of them, and properly label container or drum. Personnel will then decontaminate their hard hats and boots with an aqueous solution of detergent or other appropriate cleaning solution. These items then will be hand-carried to the next station. Remove inner gloves.
- Thoroughly wash hands and face before leaving CRZ.
- Sanitize respirators and place in a clean plastic bag.

8.4 Sampling and Processing Equipment Decontamination

To prevent sample cross-contamination, sampling and processing equipment in contact with soil, sediment, or water samples will undergo the following decontamination procedures when work is completed in the CRZ and prior to additional use:

1. Rinse with potable water and wash with scrub brush.
2. Wash with phosphate-free detergent (Alconox®).
3. Visually inspect the sampler and repeat the scrub and rinse step, if necessary. If scrubbing and rinsing with Alconox® is insufficient to remove visually observable tar-related contamination on equipment, the equipment will be scrubbed and rinsed using hexane (or similar type solution) until all visual signs of contamination are absent.
4. Rinse external sampling equipment with potable water three times prior to use. Rinse homogenizing equipment once with potable water and three times with distilled water prior to and between sample processing.

8.5 Handling of Investigation-Derived Waste

All remaining soil or sediment, fluids used for decontamination of sampling equipment, and sample collection disposable wastes (e.g., gloves, paper towels, foil, or others) will be placed into appropriate labeled containers and staged on site for disposal.

8.5.1 Disposable PPE

Disposable PPE may include Tyvek suits, inner latex gloves, and respirator cartridges. Dispose of PPE according to the requirements of the client and state and federal agencies.

8.5.2 Non-Disposable PPE

Non-disposable PPE may include respirators and boots and gloves. When decontaminating respirators, observe the following practices and procedures:

- Wipe out the respirator with a disinfecting pad prior to donning.
- Decontaminate the respirator on site at the close of each day with an approved sanitizing solution.

When decontaminating boots and gloves, observe the following practices and procedures:

- Decontaminate the boots or gloves outside with a solution of detergent and water; rinse with water prior to leaving the site.
- Protect the boots or gloves from exposure by covering with disposable covers such as plastic to minimize required decontamination activities.

8.6 Sanitizing of PPE

Respirators, reusable protective clothing, and other personal articles must not only be decontaminated before being reused, but also sanitized. The insides of masks and clothing become soiled due to exhalation, body oils, and perspiration. Manufacturer's instructions should be used to sanitize respirator masks. If practical, reusable protective clothing should be machine-washed after a thorough decontamination; otherwise, it must be cleaned by hand.

8.7 Emergency Personnel Decontamination

Personnel with medical problems or injuries may also require decontamination. There is the possibility that the decontamination may aggravate or cause more serious health effects. If prompt lifesaving, first aid, and medical treatment are required, decontamination procedures will be omitted. In either case, a member of the site management team will accompany contaminated personnel to the medical facility to advise on matters involving decontamination.

8.8 Containment of Decontamination Fluids

As necessary, spill control measures will be used to contain contaminated runoff that may enter into clean areas. Use plastic sheeting, hay bales, or install a spill control system to prevent spills and contain contaminated water.

8.9 Pressure Washing

The following procedure is required when using high-pressure washing equipment for decontamination purposes:

- Wear modified Level D protection, including a face shield and safety goggles.
- Verify that other personnel are out of the area prior to decontamination.
- Secure the area around the decontamination pad with cones, caution tape, or barricades.
- Verify that safe work practices and precautions are taken to minimize the potential for physical injury from high-pressure water spray. Follow the manufacturer's operating instructions.
- The pressure washer wand must be equipped with a safety release handle.
- Verify that the area is clean after equipment is decontaminated. Barricades, cones, or caution tape must be left in place and secured at all times.

9 Health and Safety Training and Informational Programs

This section describes the health and safety training and informational programs with which Anchor QEA project site personnel must comply. All certifications required in this section will be kept on internal file.

9.1 Initial Project Site Orientation

Work on all Anchor QEA project sites requires participation in an initial health and safety orientation presented by the PM or FL that will consist of, at a minimum, the following topics:

- A review of the contents of this HASP, including the Scope of Work and associated site hazards and control methods and procedures.
- Provisions of this plan are mandatory for all Anchor QEA personnel assigned to the project.
- Anchor QEA subcontractors are also expected to follow the provisions of this plan unless they have their own HASP that covers their specific activities related to this project and includes the minimum requirements of this HASP.
- All visitors to the work site will also be required to abide by the requirements of this plan.
- Personnel assigned to perform work at the project site, working under the provisions of this HASP, will be required to read the plan and must sign the Health and Safety Plan Acknowledgement Form to confirm that they understand and agree to abide by the provisions of this plan. Personnel not directly affiliated with the project (i.e., visitors) may also be required to sign the Liability Waiver.

9.2 Daily Safety Meetings

Daily safety meetings ("tailgate meetings") make accident prevention a top priority for everyone and reinforce awareness of important accident-prevention techniques. The following daily safety meeting procedures and practices are required:

- Daily safety meetings will be held each morning prior to conducting site activities.
- The Daily Safety Briefing form in Appendix A will be used to document each meeting.
- Copies of the completed Daily Safety Briefing forms will be maintained on site during the course of the project.

9.3 End-of-Day Wellness Checks

Similar to the daily safety meetings, field staff will gather at the end of the day to verify group health and wellness and discuss any near misses that occurred that day. The wellness checks will be recorded on that day's Daily Safety Briefing form.

9.4 Hazardous Waste Operations Training

Personnel working on project sites that present a potential exposure to hazardous wastes or other hazardous substances shall be trained in accordance with the requirements of the 29 CFR 1910.120 (HAZWOPER) regulation. Training requirements will consist of the following:

- Field personnel must complete a minimum of 40 hours of hazardous waste activity instruction.
- Field personnel must complete a minimum of 3 days of supervised field instruction.
- Field personnel assigned to the site will also have received 8 hours of refresher training if the time lapse since their previous training has exceeded 1 year.
- On-site managers and supervisors directly responsible for employees engaged in hazardous waste operations will receive an additional 8 hours of supervisory training.
- Field personnel shall be current in first aid/CPR training offered by the American Red Cross or equivalent.
- Other training may be required depending on the task to be performed (e.g., confined space, excavation/trenching, underground storage tank removal, fall protection, respiratory protection, and hazard communication).

9.5 Transportation Worker Identification Credential

All Anchor QEA field personnel will maintain current Transportation Worker Identification Credential status, pursuant to the Maritime Transportation Security Act of 2002, unless this requirement is waived specifically in writing by relevant property owners.

9.6 Hazard Communication Program

The purpose of hazard communication (Employee Right-to-Know) is to ensure that the hazards of all chemicals located at the field project site are communicated to all Anchor QEA personnel and subcontractors according to 29 CFR 1926.59. Refer to the Anchor QEA Hazard Communication Program document for additional information.

Every container of hazardous materials must be labeled by the manufacturer, who must also provide an SDS upon initial order of the product and upon request thereafter. The actual format may differ from company to company (e.g., National Fire Protection Association, Hazardous Material Information System, or other), but the labels must contain similar types of information. Maintain manufacturer labels if possible. The label may use words or symbols to communicate the following:

- Introduction
- Hazard(s) identification
- Composition/information on ingredients
- First-aid measures
- Fire-fighting measures

- Accidental release response measures
- Handling and storage
- Exposure controls/personal protection
- Physical and chemical properties
- Stability and reactivity properties
- Toxicological properties
- Ecological properties
- Disposal considerations
- Transport considerations
- Regulatory information
- Other information, including at a minimum, label preparation or last revision date

SDSs for all chemicals brought onto the site or anticipated to be used on site shall be provided in Appendix C of this HASP. These SDSs shall be readily available for reference by site personnel and emergency response personnel.

Hazardous materials received without proper labels shall be set aside and not distributed for use until properly labeled.

If a hazardous chemical is transferred into a portable container (approved safety can), even if for immediate use only, the contents (e.g., acetone or gasoline) of the portable container must be identified.

9.7 Respiratory Protection Training

Anchor QEA employees who use respiratory protection must be trained in accordance with Anchor QEA's RPP, as required by 29 CFR 1910.134. This training includes the following:

- Medical evaluations of employees required to use respirators
- Fit testing procedures for tight-fitting respirators
- Procedures for proper use of respirators in routine and reasonably foreseeable emergency situations
- Procedures and schedules for cleaning, disinfecting, storing, inspecting, repairing, discarding, and otherwise maintaining respirators
- Training of employees in the respiratory hazards to which they are potentially exposed during routine and emergency situations
- Training of employees in the proper use of respirators, including putting on and removing them, any limitations on their use, and their maintenance

See Section 10.2 for additional information.

10 General PPE Requirements

The minimum level of PPE should be selected according to the hazards that may be encountered during site activities in accordance with established U.S. Environmental Protection Agency (EPA) levels of protection (D and C). Only PPE that meets American National Standards Institute (ANSI) standards shall be worn. Site personnel must maintain proficiency in the use and care of PPE. Damaged or defective PPE must be replaced and may not be used. Anchor QEA will provide all necessary PPE for its employees as described in this HASP.

Refer to Section 5 for site-specific job task and level-of-protection requirements.

10.1 Minimum Requirements – Level D Protection

The minimum level of protection on project sites will be Level D protection, which consists of the following equipment:

- Standard work uniform/coveralls
- Work boots with safety toe conforming to ASTM International (ASTM) F2412-05/ASTM F2413-05
- Approved safety glasses or goggles (meets ANSI Z87.1 – 2010 requirements for eye protection)
- Hard hat (meets ANSI Z89.1 – 1986 requirements for head protection)
- Traffic safety vest
- Hearing protection when there are high noise levels

Level D protection will be used only when:

- The atmosphere contains no known hazards
- Work functions preclude splashes, immersions, or the potential for unexpected inhalation of, or contact with, hazardous concentrations of chemicals
- Atmospheric concentrations of contaminants are less than the Permissible Exposure Limit (PEL) and/or Threshold Limit Value (TLV)

10.1.1 Modified Level D Protection Requirements

Depending on the Scope of Work and the potential hazards to be encountered, Level D protection shall be modified to include additional protective equipment such as USCG-approved PFDs, face shields/goggles, chemical-resistant clothing, and disposable gloves of varying materials depending on the chemical substances involved. An upgrade to Modified Level D occurs when there is a possibility that contaminated media can contact the skin or work uniform, or if unique, site-specific hazards exist.

10.2 Respiratory Protection Requirements

Respiratory protection is not anticipated to be required for the Scope of Work. This section is provided for reference.

Respiratory protection devices may potentially be used for protection against particulates and organic vapors (OVs) during the course of an Anchor QEA field project. The need for respiratory protection will be determined by air monitoring results and site conditions. However, engineering and administrative controls must first be evaluated for use as the primary controls for protection against site respiratory hazards. In the event that engineering and administrative controls are deemed not feasible, respiratory protection will be required.

10.2.1 Level C Protection Requirements

An upgrade to Level C protection occurs when the results of air monitoring reveal that action levels have been exceeded. An upgrade to Level B protection occurs when the results of air monitoring reveal that action levels have been exceeded.

Level C protection, in addition to Level D equipment, involves the use of full-face and/or half-face air-purifying respirators equipped with P-100/OV, high-efficiency particulate air (HEPA)-OV, or equivalent (OSHA/National Institute for Occupational Safety and Health [NIOSH] approved).

Level C protection shall be used in the following situations:

- When there is a recognized need for protection against particulates, OVs, or other airborne contaminants during the course of the project.
- During activities where product odors or exposure symptoms are noted.

If, during the use of respiratory protection, any unusual odors or other evidence of elevated concentrations of chemicals in the workers' breathing zone is noted, the work shall be stopped, workers shall exit the work area, and the PM and SSHO shall be contacted for instructions.

10.2.2 Cartridge Change-Out Schedule

Field personnel must understand the limitations of air-purifying respirators and the End-of-Service Life cartridge change-out schedule for the particular type of respirator that will be used. Manufacturer's data has been evaluated for three types of respirators: Scott, MSA, and Survivair.

See Table 10-1 for an OV cartridge change-out schedule for total hydrocarbons and benzene.

Table 10-1
Respirator Cartridge Change-Out Schedule

Total Hydrocarbons (Toluene, Ethylbenzene, Xylenes) Air Concentration (ppm)	Change-out Schedule			
	SCOTT642 OV/Acid Gas642 OV642 MPC Cartridges	MSA Ultra Twin GME Cartridge	Survivair OV Cartridge 100100	Survivair OV/Acid Gas Cartridge 100300/1053 (includes P-100)
< 150	8 hours	8 hours	8 hours	8 hours
> 150 to 200	8 hours	8 hours	8 hours	8 hours
> 200 to 250	8 hours	8 hours	8 hours	8 hours
> 250	Stop Work	Stop Work	Stop Work	Stop Work
Benzene Air Concentration (ppm)	**SCOTT642 OV/Acid Gas642 OV642 MPC Cartridges**	**MSA Ultra Twin GME Cartridge**	**Survivair OV Cartridge 100100**	**Survivair OV/Acid Gas Cartridge 100300/1053 (includes P-100)**
< 10	8 hours	8 hours	8 hours	8 hours
> 10 to 100	8 hours	8 hours	8 hours	7 hours
> 100 to 125	7 hours	7 hours	7 hours	6 hours
> 125	Stop Work	Stop Work	Stop Work	Stop Work

Personnel using a respirator that is not listed above should contact their SSHO to determine the change-out schedule for the particular respirator used. Any questions regarding the site-specific respiratory protection program must be directed to the FL and/or PM.

All cartridges will be changed a minimum of once daily or more frequently if personnel begin to experience increased inhalation resistance. Cartridges will be changed immediately if breakthrough, a chemical warning property (e.g., eye, nose, or throat irritation or odor), or cartridge end-of-life indicator activation occurs. The FL will review this requirement after monitoring the employee's breathing zone for site contaminants and will revise this schedule as may be necessary to avoid over-exposure.

For respirators other than those listed in this section and specific OVs not listed in this section, the following guidelines shall be followed for changing out OV cartridges:

- If the organic chemical's boiling point is less than 70°F and the concentration is greater than 200 parts per million (ppm), contact the SSHO to discuss cartridge change-out and options for respiratory protection.
- If the physical work rate exceeds a moderate level, replace cartridges every 4 hours of work.
- If relative humidity exceeds 85%, replace cartridges every 4 hours of work.

10.2.3 Level B and A Protection Requirements

An upgrade to Level B protection occurs when the results of air monitoring reveal that action levels have been exceeded (site personnel must meet training requirements). Prior to upgrading to Level B, stop work and contact the PM and/or FL and SSHO if air monitoring results exceed the Level C protection levels.

10.2.4 Respirator Fit Testing

All Anchor QEA personnel who may be required to wear an air-supplied or negative-pressure air-purifying respirator in the performance of their work duties shall be fit-tested on an annual basis. Employees who wear a respirator for more than 30 days per year shall be enrolled in a medical surveillance program as detailed in Section 13 of this HASP.

Employees shall have the opportunity to handle the respirators and wear them in normal air for a familiarity period prior to fit-testing. On each occasion that employees don a respirator for work purposes, they shall test the piece-to-face seal by use of the following positive and negative pressure tests:

- ***Positive Pressure Test:*** With the exhaust port(s) blocked, the positive pressure of slight exhalation should remain consistent for several seconds.
- ***Negative Pressure Test:*** With the intake ports blocked, the negative pressure of slight inhalation should remain constant for several seconds.

Air-purifying respirators shall not be worn when conditions prevent a seal of the respirator to the wearer. Such conditions may be the growth of a beard, sideburns, a skull cap that projects under the face piece, or temple pieces on glasses. No employee may wear a beard if it interferes with the fit of the respirator. Also, the absence of one or both dentures can seriously affect the fit of a face-piece and should be worn at all times that respirators are being used.

10.2.5 Respirator Cleaning, Maintenance, and Inspection

All respirators used on site shall be cleaned and maintained in the following manner:

- Remove filters and cartridges.
- Visually inspect face piece and parts, discard faulty items.
- Remove all elastic headbands.
- Remove exhalation cover and inhalation valves.
- Wash, sanitize, and rinse face piece. Wash any parts that were removed separately.
- Dry the mask. Wipe face pieces and valves.
- Disassemble and clean the exhalation valve.
- Visually inspect face piece and all parts for deterioration, distortion, or other faults that might affect the performance of the respirator.

- Replace any questionable or faulty parts.
- Reassemble mask and visually inspect completed assembly.
- Seal mask in plastic bag.

11 General Air Monitoring Requirements

11.1 General Requirements

In general, air monitoring shall be conducted when the possibility of hazardous atmospheres, chemical volatilization, or contaminated airborne dust exists (e.g., from intrusive activities involving contaminated soils or groundwater, developing new monitoring wells, working with wells containing known COCs, confined space entry, or others).

Air movers or other engineering controls shall be used to exhaust or dilute solvent vapors emanating from monitoring wells or hazardous atmospheres in confined spaces prior to the use of respiratory protection devices.

Site-specific air monitoring action levels are provided in Section 5.2.

Of particular note, recent land-based drilling activities encountered a subsurface vapor/gas pocket of unknown but presumably inert chemistry. If at any time vapor or gas venting is noted during drilling from a boring (e.g., hissing noise, liquid spray), work will stop immediately, the drill rig will be shut down, all staff will vacate the area, and the SSHO will be contacted before work may resume.

11.2 Real-Time Air Monitoring Equipment

As applicable, OV concentrations shall be monitored in the field with either a photoionization detector (PID) or flame ionization detector (FID). Flammable vapors and/or gasses are monitored with an oxygen/Lower Explosive Limit (O_2/LEL) real-time instrument. OV measurements are usually taken in the breathing zone of the worker while O_2/LEL measurements are taken at the point of operation (e.g., monitoring well head or auger point).

As applicable, airborne dust/particulate concentrations shall be measured using a real-time aerosol monitor (using a scattered light photometric sensing cell) when there are visible signs of potentially contaminated airborne dust. Both area and personal air monitoring readings are to be taken to characterize site activities.

As applicable, colorimetric detector tubes shall be used to monitor specific COCs such as benzene or vinyl chloride if there is a possibility that they may be present in elevated concentrations based upon the background of the project site, the Scope of Work, and conditions discovered at the site.

As applicable, other real-time air monitoring equipment, such as hydrogen cyanide meters, may be utilized depending upon the Scope of Work and COCs.

Air monitoring results shall be documented on the Daily Air Monitoring Record form (see Appendix A) or in the field logbook.

11.3 Time-Integrated Air Monitoring Equipment

Some Anchor QEA projects may require the use of time-integrated air monitoring equipment to determine employee exposures to COCs. Time-integrated air monitoring would be required if there is the possibility that employees would be exposed to concentrations of a COC that approach or exceed an established exposure limit.

Typical time-integrated sampling methods will usually involve the use of personal sampling pumps and associated filter and/or charcoal sampling media, or the use of diffusion-based sampling media. Exposed sampling media is normally sent to an accredited laboratory for analysis.

Contact the SSHO for consultation and assistance with the performance of time-integrated air monitoring activities.

11.4 Equipment Calibration and Maintenance

Calibration and maintenance of air monitoring equipment shall follow manufacturer specifications and must be documented. Recalibration and adjustment of air monitoring equipment shall be completed as site conditions and equipment operation warrant. Record all air monitoring equipment calibration and adjustment information on the Daily Air Monitoring Record form (see Appendix A) and in the field logbook.

11.5 Air Monitoring Action Levels

Air monitoring action levels have been developed that stipulate the chemical concentrations in the breathing zone that require an upgrade in level of PPE.

Air monitoring action levels are typically set at one-half of the OSHA PEL, NIOSH Recommended Exposure Limit, or the American Conference of Governmental Industrial Hygienists TLVs. The rationale for establishing action levels is based on the available data that characterize COCs in site media.

Air monitoring measurements shall generally be taken in the breathing zone of the worker most likely to have the highest exposure. Transient peaks will not automatically trigger action. Action will be taken when levels are consistently exceeded in a 5-minute period. Similarly, if chemical odors are detected that are a nuisance, bothersome, or irritating, an upgrade in respiratory protection can provide an extra level of comfort or protection when conducting site activities.

11.6 Air Monitoring Frequency Guidelines

In general, conduct periodic air monitoring when:

- It is possible that an immediately dangerous to life or health condition or a flammable atmosphere has developed (e.g., confined space entry or intrusive activities)

- There is an indication that exposures may have risen over established action levels, PELs, or published exposure levels since the last monitoring. Look for a possible rise in exposures associated with the following situations:
  - **Change in site area:** Work begins on a different section of the site.
  - **Change in on-site activity:** One operation ends and another begins.
  - **Change in contaminants:** Handling contaminants other than those first identified.
  - Visible signs of particulate exposure from intrusive activities such as drilling, boring, or excavation.
  - Perceptible chemical odors or symptoms of exposure.
  - Handling leaking drums or containers.
  - Working with obvious liquid contamination (e.g., a spill or lagoon).
  - Conduct air monitoring when the possibility of volatilization exists (such as with a new monitoring well or a well containing known COCs).

12 Health and Safety Procedures and Practices

In addition to the task-specific JSAs listed in Section 6.1 and presented in Appendix B, this section lists the health and safety procedures and practices applicable to this project. For additional information, consult with the PM.

12.1 Physical Hazards and Controls

12.1.1 General Site Activities

Observe the following general procedures and practices to prevent physical hazards:

- Legible and understandable precautionary labels shall be affixed prominently to containers of potentially contaminated soil, sediment, water, and clothing.
- No food or beverages shall be present or consumed in areas that have the potential to contain COCs and/or contaminated materials or equipment.
- No tobacco products or cosmetics shall be present or used in areas that have the potential to contain COCs and/or contaminated materials or equipment.
- An emergency eyewash unit shall be located immediately adjacent to employees who handle hazardous or corrosive materials, including decontamination fluids. All operations involving the potential for eye injury or splash must have approved eyewash units locally available capable of delivering at least 0.4 gallons per minute for at least 15 minutes.
- Personnel working within 10 feet of bodies of water shall wear USCG-approved PFDs.
- Certain project sites may have newly finished work (e.g., concrete, paving, framing, habitat reconstruction, or sediment caps) that may be damaged by unnecessary contact, or that could cause dangerous conditions for personnel (e.g., slipping, sinking, or tripping). Personnel working in or around these areas shall communicate with the PM, FL, and property owner as needed to prevent damaging new work or entering dangerous conditions.
- Generally, all on-site activities will be conducted during daylight hours. If work after dusk is planned or becomes necessary due to an emergency, adequate lighting must be provided.
- Hazardous work, such as handling hazardous materials and heavy loads and operating equipment, should not be conducted during severe storms.
- All temporary electrical power must have a ground-fault circuit interrupter (GFCI) as part of its circuit if the circuit is not part of permanent wiring. All equipment must be suitable and approved for the class of hazard present.

12.1.2 Slips, Trips, and Falls

Observe the following procedures and practices to prevent slips, trips, and falls:

- Inspect each work area for slip, trip, and fall potential prior to each work task.

- Slip, trip, and fall hazards identified must be communicated to all personnel. Hazards identified shall be corrected or labeled with warning signs to be avoided.
- All personnel must be aware of their surroundings and maintain constant communication with each other at all times.

12.1.3 Ergonomic Considerations

Certain field tasks may involve workers in fixed positions (e.g., observing subcontractor work) or performing repetitive motions over a period of time (e.g., sediment sample processing). It is important that workers self-monitor for ergonomic fatigue (e.g., soreness, tightness, stiffness, or pain in muscles) and make adjustments to work tasks, body positions, or work areas so that ergonomic stressors are minimized. Suggestions for decreasing the likelihood of ergonomic stress include the following:

- Limit fixed positions. Periodically vary standing and sitting positions, take frequent short walks, and modify observation locations when possible.
- Minimize extreme postures. Conduct work tasks using comfortable postures (particularly if the tasks are repetitive), and use tools or structures to minimize the need to hold or work with materials or access the work area.
- Limit contact stress. Be aware of soft tissue resting on hard surfaces, and limit these occurrences (e.g., use comfortable footwear, and use tools to hold materials).
- Contact the Field Mobilization Team in advance for prolonged field efforts that involve a field trailer. This group can set up field staff with a monitor, mouse, and keyboard so they are not working solely on laptops.
- Take breaks from work tasks, particularly repetitive ones.
- Consider performing stretching exercises before and during work activities, if those tasks are anticipated to be long in duration and/or strenuous.

12.1.4 Corrosive Material Handling Procedures

Corrosive materials include acids and bases. They are extremely corrosive materials with a variety of uses. Acids include hydrochloric, nitric, and sulfuric acids. Bases include sodium hydroxide. Observe the following procedures when working with corrosive materials:

- Wear gloves and eye-splash protection while using acid dispensed from a small dropper bottle during water sampling.
- Wear a full-face, air-purifying respirator equipped with combination cartridges (OV/acid gas) as well as Tyvek coveralls and nitrile gloves for large volume applications.
- Have an eyewash bottle and/or portable eyewash station on site.
- Do not add anything into a virgin chemical drum, including unused product.

- Avoid mixing strong acids and bases. Consult the SSHO for task-specific evaluation. If mixing is absolutely necessary, do it slowly. Avoid vapors or fumes that are generated.
- When diluting acids and bases, add the acid or base to water in small quantities and mix cautiously.

12.1.5 Sediment Core Sampling

Sediment and porewater samples may be collected using vibracore or other drilling equipment operated from an on-water vessel. Please see Sections 12.1.17.1 and 12.1.17.2 for additional safety information regarding working on or near water.

All operations involving the use of powered sediment coring rigs will follow generally accepted drilling/coring practices. One person will be assigned the responsibility of Lead Driller/Corer. Additional personnel will assist with equipment as needed. The Lead Driller/Corer will be responsible for operating the drilling/coring rig and ensuring safety.

General rules associated with drilling/coring rig operations will be as follows:

- While drilling, all non-essential personnel shall remain at a distance that is past the radius of any moving parts.
- All operators and team members will be familiar with the rig operations and will have received practical training.
- All personnel will be instructed in the use of the emergency kill switch/shutdown on the drill rig.
- No loose-fitting clothing, jewelry, or free long hair is permitted near the drilling rig or moving machinery parts.
- A first aid kit and fire extinguisher will be available at all times.
- No drilling will occur during impending electrical storms or tornadoes, or when rain, ice, snow, or wind conditions create undue potential hazards.
- Never allow "horsing around" within the vicinity of the drill rig and tool and supply storage areas, even when the drill rig is shut down.

12.1.6 Dry Ice (Solid Carbon Dioxide) Use

Subsurface sediment samples collected for nonaqueous phase liquid mobility testing will be stored and shipped with dry ice following processing. Dry ice (solid form of carbon dioxide) presents the following three types of hazards:

- Explosion: Due to pressurized gas produced during sublimation, dry ice can explode if stored in an airtight container.
- Suffocation: Carbon dioxide gas may create an oxygen-deficient atmosphere by displacing breathable air.

- Direct contact: Dry ice is very cold (-109°F/-78°C) and can cause severe frostbite to unprotected skin.

When using dry ice, the following precautions must be taken:

- Always handle dry ice with thermal gloves, never with bare hands.
- Avoid contact with unprotected skin at all times (e.g., hands, forearms).
- Dry ice must be stored and handled in only well-ventilated areas to prohibit creation of an oxygen-deficient atmosphere.
- Do not store dry ice in airtight containers.
- Packaging, marking, labeling, loading, and shipping/transporting samples with dry ice may be carried out only by staff who have received specific training required by the U.S. Department of Transportation (DOT). Contact Chris Torell in the Syracuse office at (315) 414-2017 for assistance with ensuring applicable staff are appropriately trained in accordance with DOT regulations.
- Shipping samples with dry ice must comply fully with courier requirements.

12.1.7 Underground/Overhead Utility Line Contact Prevention

Observe the following underground/overhead utility line contact prevention procedures and practices:

- Prior to conducting work, the PM or FL shall ensure that all existing underground or overhead utilities in the work area are located per the state or local mark-out methods. Documentation of utility mark-out shall be completed using the Utility Contact Prevention Checklist form (see Appendix A). No excavation work is to be performed until all utility mark-outs are verified.
- The PM or FL shall conduct a site survey to search for signs of other buried or overhead utilities. The results of such surveys shall be documented on the Utility Mark-out documentation form.
- The property owner or facility operator shall be consulted on the issue of underground utilities. As-built drawings shall be reviewed, when available, to verify that underground utility locations are consistent with the utility location mark-outs. All knowledge of past and present utilities must be evaluated prior to conducting work.
- If on-site subsurface utility locations are in question, a private locating service shall be contacted to verify locations. If the investigation calls for boreholes in an area not covered by the municipal One-Call system, then a private utility locate firm shall be contacted to determine the location of other underground utilities.
- The PM shall have documented verbal contact and an agreement with the fiber optic company for all work within 50 feet of any fiber optic cables.
- **Only non-destructive excavation, such as hand digging or hydro excavation, is permitted within 3 feet of underground high voltage, product, or gas lines.** Once the line

is exposed, heavy equipment can be used, but must remain at least 3 feet from the exposed line.

- Elevated superstructures (e.g., drill rig, backhoe, scaffolding, ladders, and cranes) shall remain a distance of 10 feet away from utility lines and 20 feet away from power lines. Distance from utility lines may be adjusted by the FL depending on actual voltage of the lines.
- Overhead utility locations shall be marked with warning tape or flags where equipment has the potential for contacting overhead utilities.

Table 12-1 shows the minimum clearances required for energized overhead electrical lines.

Table 12-1
Overhead Utility Clearance Requirements

Minimum Clearance from Energized Overhead Electric Lines	
Nominal System Voltage	**Minimum Required Clearance**
0 to 50 kV	10 feet
51 to 100 kV	12 feet
101 to 200 kV	15 feet
201 to 300 kV	20 feet
301 to 500 kV	25 feet
501 to 750 kV	35 feet
751 to 1,000 kV	45 feet

Note:
Whenever equipment operations must be performed closer than 20 feet from overhead power lines, the FL must be notified. When clearance to proceed is received from the FL, the electric utility company must be contacted to turn the power off or physically insulate (protect) the lines if the operation must be performed closer to the power line than is allowed in this table. For voltages not listed on this table, add 0.4 inches per kV to obtain the safe distance between equipment and power lines.

12.1.8 Electric Safety

Observe the following procedures and practices to prevent electric shock:

- General
  - Use only appropriately trained and certified electricians to perform tasks related to electrical equipment. A good rule of thumb is to defer any task that would not normally and reasonably be completed by the average public consumer.
  - Each circuit encountered will be considered live until proven otherwise.
  - Only proper tools will be used to test circuits.
  - No wire will be touched until the circuit is determined to be de-energized.
- Extension Cords
  - All extension cords used on any project will be three-pronged.
  - All extension cords will be in good working order.

- Each extension cord ground will be tested for continuity on at least a quarterly basis and marked to indicate when the inspection occurred.
- Each extension cord will be visually inspected before each use.
- If any extension cord is found in disrepair or fails the continuity test, it will be taken out of service.
- Any extension cord that does not have the grounding pin will be taken out of service and not used.
- Extension cords will not be used in place of fixed wiring.
- Extension cords will not be run through holes in walls, ceilings, or floors.
- Extension cords will not be attached to the surface of any building.
- No extension cord will be of the "flat wire" type. Every extension cord will have each individual wire insulated and further protected by an outside cover.
- Be sure to locate extension cords out of traffic areas or, if this is unavoidable, flag cords and protect workers from tripping over them (i.e., use barricades and tape the cord down).
- Do not stage extension cords or powered equipment in wet areas, to the degree possible. Elevate cords, connections, and equipment out of puddles.

- Power Tools/Plug and Cord Sets
  - Any cord that is cut in a way that exposes insulation will be removed from service.
  - All tools and plug and cord sets will be tested for continuity.
  - If grounding pins are missing, the plug and cord will be removed from service.
  - Any tool or plug and cord set failing the continuity test will be removed from service.
  - All power tools will have three-pronged plugs unless double insulated.
- Ground-Fault Circuit Interrupters
  - Each 120-volt electrical wall receptacle providing power to the job site will be protected by a portable GFCI.
  - Each GFCI will be tested quarterly and marked to indicate when the inspection occurred.
  - Each 120-volt, single-phase, 15- and 20-ampere receptacle outlet, including those on generators, will have an approved GFCI.
  - GFCIs will be located in line as close to the piece of equipment as possible.
- Specific
  - If unsure if a task requires specific electrical training, err on the side of caution and contact the PM and FL prior to proceeding.
  - If subsurface work is to be performed, follow the guidelines in Section 12.1.6 and conduct utility locating prior to work and in accordance with local ordinances.
  - If lock out/tag out (LO/TO) procedures are required (i.e., de-energizing machinery or equipment so work may be performed), the equipment owner must provide LO/TO procedures and training. By default, the equipment owner should perform any LO/TO. If

it becomes necessary for Anchor QEA personnel to perform LO/TO tasks, contact the PM and FL prior to doing so.

- Maintain appropriate distance from overhead utilities (see Table 12-1).
- If unexpected electrical equipment is encountered (i.e., buried wire) assume it is live, stop work, and contact the PM and FL immediately.
- If working in enclosed or restricted areas where electrical hazards may be present, contact a licensed electrician or other suitably trained party to provide barriers, shields, or insulating materials to prevent electric shock.
- If working in areas where electrical hazards are present, ensure that conductive clothing and jewelry is replaced with non-conductive clothing or removed.

12.1.9 General Falls and Ladder Usage

Observe the following general falls/ladders procedures and practices:

- Assess work areas for fall hazards. A fall protection system that meets OSHA and ANSI Z3591 standards must be used if work is conducted 4 feet or more above the surface.
- Use ANSI Type 1A rated ladders.
- Ensure that ladders are placed so their rungs, cleats, and steps are parallel, level, and uniformly spaced prior to use.
- Make sure ladder rungs are sturdy and free of cracks.
- Use ladders with secure safety feet.
- Pitch ladders at a 1 horizontal to 4 vertical (1H:4V) ratio.
- Secure ladders at the top or have another person at the bottom to help stabilize it.
- Ladders used to access an upper landing surface shall extend at least 3 feet above the upper landing surface.
- Use non-conductive ladders near electrical wires.
- The top rung of a ladder should not be used as a step.
- Do not carry any object or load that could cause a loss of balance or a fall.
- If a ladder is defective, damaged, or in disrepair (i.e., broken or missing rungs, cleats, or steps; broken or split rails; corroded components; or other faulty or defective components), tag the ladder "Do Not Use" and remove it from service until repaired.

12.1.10 Heavy Equipment Operations

Observe the following heavy equipment operations procedures and practices:

- Wear leather gloves while attaching support members to protect against pinching injuries.
- While working from elevated levels greater than 4 feet, ensure that all employees have fall protection that meets OSHA and ANSI Z3591 standards.
- Do not stand under loads that are being raised or lowered with cranes or aerial lifts.

- The subcontractor or Anchor QEA equipment operator must conduct pre-operational inspections of all equipment. In addition, daily inspections will be conducted on the equipment prior to site activities.
- Maintain the appropriate distance from overhead utilities (see Table 12-1):
- Always stay out of the swing radius of all heavy equipment. Always use a spotter during movement of equipment. The spotter and others, as appropriate, shall maintain constant communication with the operator.
- All operators must have adequate training and be qualified to operate the particular heavy equipment unit.
- Conduct a site evaluation to determine proper positioning for the unit. Make sure the surface is level. Cordon off holes, drop-offs, bumps, or weak ground surfaces.
- When using a crane, do not use hands when the load is being lifted or lowered. Use non-conductive tag line to help direct and position the load.
- Never climb a raised platform or stand on the mid-rail or top-rail.
- Tools should always be hung or put into a belt whenever possible

12.1.11 Drilling with Direct Push Technology

General rules associated with direct push technology (DPT) intrusive activities are as follows:

- Maintain all equipment in a safe condition.
- Keep all guards in place during use.
- Before DPT sampling is started, ensure that everyone who operates the rig has had adequate training and is thoroughly familiar with the DPT rig, its controls, capabilities, and operating manual.
- Set-up on stable and level terrain.
- Outriggers shall be extended per the manufacturer's specifications.
- Do not place outriggers on underground structures such as vaults, manholes, stormwater inlets, catch basins, or well boxes.
- Use proper dunnage, cribbage, plates, or wooden blocks between outriggers and supporting surfaces.
- The Driller and helper must be present during all active operations and TEST THE TWO KILL SWITCHES DURING EACH STARTUP.
- The DPT rig helper and other site personnel must know the location of the two emergency shutoff switches.
- The area around the drilling operation must be cordoned off/barricaded.
- When hazardous conditions are deemed present, the operation must be shut down.
- Team members shall not wear loose clothing, free long hair, jewelry, or equipment that might become caught in moving machinery. Secure PPE close to the body to avoid getting caught in moving parts.

- Unauthorized personnel must be kept clear of the DPT rig.
- Shut down, lock, and tag out the DPT rig to make repairs or adjustments or to lubricate fittings. Release all pressure on the hydraulic systems, the drilling fluid system, and the air pressure systems of the drill rig prior to performing maintenance.
- Identify and understand parts of the equipment that may cause crushing, pinching, rotating, or similar injuries.
- Neatly stack pipe, rods, or similar on racks or sills to prevent spreading, rolling, or sliding.
- Wear proper work gloves when the possibility of pinching or other injury may be caused by moving or handling large or heavy objects.
- Establish a system of responsibility for the operator and helpers to follow during the series of various activities, such as connecting and disconnecting sections and inserting and removing the sections.
- Never reach behind or around rotating equipment for any reason.
- Clean equipment only when the DPT rig is in neutral and the equipment has stopped.
- Don't place hands, feet, and/or limbs into or through openings of equipment frames or structures that were not intended to be used in such a fashion.

12.1.12 Drilling with a Hollow Stem Auger or Rotary/Sonic Drill Rig

All operations involving the use of powered drilling rigs will follow generally accepted drilling practices. One person will be assigned the responsibility of Lead Driller. Additional personnel will assist with equipment as needed. The Lead Driller will be responsible for operating the drilling rig and ensuring safety.

General rules associated with drilling rig operations will be as follows:

- An Exclusion Zone will be established around the drilling rig using barricade tape as a physical barrier.
- While drilling, all non-essential personnel shall remain at a distance that is past 1.5 times the radius of the boom, whenever possible. Workers (e.g., drillers, hydrogeologists, etc.) remaining around the drill rig will be kept to a minimum.
- All vehicles and heavy equipment must be parked at least 50 feet from the drill rig when lowering the mast.
- All operators and team members will be familiar with the rig operations and will have received practical training.
- All personnel will be instructed in the use of the emergency kill switch/shutdown on the drill rig.
- Hard-hats, steel-toed boots conforming to ASTM F2412-05/ASTM F2413-05, goggles or safety glasses with side shields, hearing protection, and gloves for hand protection are required.

- As project conditions dictate (i.e., the presence of puncture or crushing risks to the feet), protective shanks and/or metatarsal guards conforming to ASTM F2412-05/ ASTM F2413-05 must be worn.
- No loose-fitting clothing, jewelry, or free long hair is permitted near the drilling rig or moving machinery parts.
- Before leaving the controls, the Lead Driller will shift the transmission controlling the rotary drive into neutral and place the feed level in neutral. Before leaving the vicinity of the drill, the Lead Driller will shut down the drill engine.
- Drilling must cease immediately if combustible gas concentrations greater than 20% of the LEL are detected in the work area.
- A first aid kit and fire extinguisher will be available at all times.
- If lubrication fittings are not accessible with guards in place, machinery must be stopped for oil and greasing.
- The work area around the borehole shall be kept free of obstructions and undue accumulations of oil, water, ice, or circulating fluids.
- No drilling will occur during impending electrical storms or tornadoes, or when rain, ice, snow, or wind conditions create undue potential hazards.
- During freezing weather, do not touch any metal parts of the drill rig with exposed flesh. Freezing of moist skin to metal can occur almost instantaneously.
- The driller will not attempt to reach a well or borehole location in a manner that compromises the safety of the rig or team.
- All well or borehole locations will be inspected by the drill team to ensure that a stable surface exists.
- Before raising the drill mast, the Lead Driller will check for overhead obstructions.
- Before the mast of a drill rig is raised, the drill rig must first be leveled and stabilized with leveling jacks and/or cribbing. Re-level the drill rig if it settles after initial setup. Lower the mast only when the leveling jacks are down, and do not raise the leveling jack pads until the mast is lowered completely.
- The drill rig shall be driven or moved only after the mast has been lowered.
- The leveling jacks shall not be raised until the derrick is lowered.
- Adequately cover or protect all unattended boreholes to prevent drill rig personnel or site visitors from stepping or falling into the borehole.
- Maintain professional behavior at all times in the work area, even when the rig is shut down.

Rotary Drill Rig Operations:

- Drillers must never engage the rotary clutch without watching the rotary table and ensuring that it is clear of personnel and equipment.

- Unless the drill rig is equipped with an automatic feed control, the brake must not be left unattended without first being tied down.
- Drillers will not add or remove pipe from the drill stem without assistance from the driller's helper.
- Drill pipe must not be hoisted until the driller is sure that the pipe is latched and the drilling assistant has signaled that he/she may safely hoist the load.
- During instances of unusual loading of the derrick or mast, such as when making an unusually hard pull, only the driller will be on the rig floor and no one will be on the rig or derrick.
- The brakes of every drilling rig must be tested at the beginning of each shift to determine whether they are in good order.
- A hoisting line with a load imposed will not be permitted to be in direct contact with any derrick member or stationary equipment unless it has been specifically designed for line contact.
- Hoisting control stations must be kept clean and controls shall be labeled as to their functions.
- Under no circumstances will personnel be permitted to ride the traveling block or elevators, nor will the cat line be used as a personnel carrier.

12.1.13 Hand and Power Tools

Observe the following procedures and practices when working with hand and power tools:

- Keep hand tools sharp, clean, oiled, dressed, and not abused.
- Worn tools are dangerous. For example, the "teeth" in a pipe wrench can slip if worn smooth, an adjustable wrench will slip if the jaws are sprung, and hammerheads can fly off loose handles.
- Tools subject to impact (e.g., chisels, star drills, and caulking irons) tend to "mushroom." Keep them dressed to avoid flying spalls, and use tool holders.
- Do not force tools beyond their capacity.
- Flying objects can result from operating almost any power tool, so always warn people in the vicinity and use proper eye protection.
- Each power tool should be examined before use for damaged parts, loose fittings, and frayed or cut electric cords. Tag and return defective tools for repairs. Ensure that there is adequate lighting, inspect tools for proper lubrication, and relocate tools or material that could "vibrate into trouble."
- Compressed air must be shut off or the electric cord unplugged before making tool adjustments. Air must be "bled down" before replacement or disconnection.
- Proper guards or shields must be installed on all power tools before issue. Do not use improper tools or tools without guards in place.
- Replace all guards before startup. Remove cranks, keys, or wrenches used in service work.

12.1.14 Motor Vehicle Operation

All drivers are required to have a valid driver's license, and all vehicles must have appropriate state vehicle registration and inspection stickers. **Anchor QEA prohibits the use of hand-held wireless devices while driving any vehicle for business use at any time, for personal use during business hours, and as defined by law**. Additionally, site-specific motor vehicle requirements must be followed, if any.

When driving to, from, and within the job site, be aware of potential hazards including:

- Vehicle accidents
- Distractions
- Fatigue
- Weather and road conditions

To mitigate these hazards, observe the following procedures and practices regarding motor vehicle operation:

- Before leaving, inspect fuel and fluid levels and air pressure in tires, and adjust mirrors and seat positions appropriately.
- Wear a seat belt at all times and make sure that clothing will not interfere with driving.
- Plan your travel route and check maps for directions or discuss with colleagues.
- Clean windows and mirrors as needed throughout the trip.
- Wear sunglasses as needed.
- Fill up when the fuel level is low (not near empty).
- Follow a vehicle maintenance schedule to reduce the possibility of a breakdown while driving.
- Stop driving the vehicle, regardless of the speed (e.g., even 5 miles per hour) or location (e.g., a private road), when the potential of being distracted by conversation exists.
- Using hand-held communication devices (e.g., cell phones) while operating any motor vehicle is prohibited.
- Get adequate rest prior to driving.
- Periodically change your seat position, stretch, open the window, or turn on the radio to stay alert.
- Pull over and rest if you are experiencing drowsiness.
- Check road and weather conditions prior to driving.
- Be prepared to adjust your driving plans if conditions change.
- Travel in daylight hours, if possible.
- Give yourself plenty of time to allow for slowdowns due to construction, accidents, or other unforeseen circumstances.
- Use lights at night and lights and wipers during inclement weather.

12.1.15 *Vehicular Traffic*

Observe the following procedures and practices regarding vehicular traffic:

- Wear a traffic safety vest when vehicle hazards exist.
- Use cones, flags, barricades, and caution tape to define the work area.
- Use a vehicle to block the work area (if conditions allow).
- Engage a police detail for high-traffic situations.
- Always use a spotter in tight or congested areas for material deliveries.
- As necessary, develop traffic control plans and train personnel as flaggers in accordance with the DOT Manual of Uniform Traffic Control Devices and/or local requirements.

See Section 7.4 for additional information regarding work in roadways.

12.1.16 *Boating Operations*

The following precautions shall be followed when conducting boating trailer and launch activities:

- Follow the trailer and boat manufacturers' instructions for securing the boat to the trailer.
- Follow the trailer manufacturer's instructions for securing the trailer to the towing vehicle.
- Prohibit site personnel from moving into trailer/vehicle pinch points without advising the vehicle operator.
- Use experienced operators when backing trailers on boat ramps.
- Wear proper work gloves when the possibility of pinching or other injury may be caused by moving or handling large or heavy objects.
- Maintain all equipment in a safe condition.
- Launch boats one at a time to avoid collisions.
- Use a spotter for vehicles backing boats to the launch area.
- Understand and review hand signals.
- Wear boots with non-slip soles when launching boats.
- Wear USCG-approved PFDs when working within 10 feet of the water.
- Keep ropes and lines coiled and stowed to eliminate trip hazards.
- Maintain three-point contact on dock/pier or boat ladders.
- Ensure that drain plugs are in place, as present.

The following precautions shall be followed when conducting boating operations:

- Maintain a current boater's license(s) as required.
- Wear USCG-approved PFDs for work activities within 10 feet of the water.
- Obtain and review information regarding dams that may be present in work areas, particularly with regard to "no boating" zones and safety buoys, cables, and warning signage.

- Maintain boat anchorage devices commensurate with anticipate currents, distance to shore, and water depths.
- Provide a floating ring buoy in the immediate boat launch/landing areas with at least 60 feet (18.3 meters) of line for a vessel less than 65 feet (19.8 meters) in length, or 90 feet (27.4 meters) of line for a vessel 65 feet (19.8 meters) or greater in length (see http://www.uscg.mil/d13/cfvs/CheckLists/Regs/28.115.pdf for more information).
- Step into the center of the boat.
- Keep your weight low when moving on the boat.
- Move slowly and deliberately.
- Steer directly across other boat wakes at a 90-degree angle to avoid capsizing.
- Steer the boat facing forward.
- Watch for floating objects in the water.
- Right-of-way is yielded to vessels on your boat's right, or starboard, and vessels with limited ability to maneuver such as any wind-propelled vessel.

The following precautions shall be followed when working on a boat:

- Observe proper lifting techniques.
- Obey lifting limits (see Section 12.1.19)
- Use mechanical lifting equipment (i.e., pulleys or winches) to move large or awkward loads.
- Wear USCG-approved PFDs for work activities within 10 feet of the water.

The safety-related items listed in Table 12-2 shall be available when conducting boating operations.

Table 12-2
Safety Equipment Specific to In-Water Work

<table>
<tr><th colspan="2">Additional Safety Equipment for Sampling Vessel per USCG Requirements:</th></tr>
<tr><td colspan="2">
• Proper vessel registration, numbering, and documentation (registered with state, certificate of vessel registration number displayed, and carrying a valid certificate of number)
• USCG-approved personal flotation devices (PFDs; or life jackets) for every person on the sampling vessel (Type II PFD required; Type I PFD preferred as it will turn most unconscious wearers face up in the water)
• Appropriate, non-expired, visual distress devices for day and night use from the following:
• Three hand-held red flares (day and night), or
• One hand-held red flare and two parachute flares (day and night), or
• One hand-held orange smoke signal, two floating orange smoke signals (day), and one electric distress light (night only)
• Alternate means of propulsion (oars or paddles)
• Dewatering device (pump or bailer)
• Properly maintained and inspected USCG-approved fire extinguishers (no fixed system = (2) B-1 or (1) B-2 type extinguishers; fixed system = (1) B-1 type extinguisher)
• Proper ventilation of gasoline-powered vessels
• Sound-producing device (whistle, bell, or horn)
• VHF 2-way radio
• Proper navigational light display
• Throwable life ring with attached line (any vessel larger than 16 feet is required to carry one Type IV [throwable] PFD)
</td></tr>
<tr><th colspan="2">Additional USCG Recommended Equipment Includes:</th></tr>
<tr><td>
• Extra visual distress signals
• Primary and spare anchor
• Heaving line
• Fenders
• First aid kit
• Flashlight
• Mirror
• Searchlight
• Sunburn lotion
• Tool kit
• Spare fuel
</td><td>
• Boat hook
• Spare propeller
• Mooring line
• Food and water
• Binoculars
• Spare batteries
• Sunglasses
• Marine hardware
• Extra clothing
• Spare parts
• Pertinent navigational chart(s) and compass
</td></tr>
</table>

12.1.17 Working Over or Near Water

12.1.17.1 Personal Flotation Devices

PFDs are not required where employees are continuously protected from the hazard of drowning by railings, nets, safety belts, or other applicable provisions.

Type III, Type V, or better USCG-approved, high-visibility PFD shall be provided and properly worn by all personnel in the following circumstances:

- On or within 10 feet of water
- On floating pipelines, pontoons, rafts, or stages
- On structures extending over or next to the water, except where guard rails or safety nets are provided for employees
- Working alone at night where there are drowning hazards, regardless of other safeguards provided
- In skiffs, small boats, or launches, unless in an enclosed cabin or cockpit
- Whenever there is a drowning hazard

The following precautions shall be followed when using PFDs:

- Prior to and after each use, the buoyant work vests or life preservers shall be inspected for defects that would alter their strength or buoyancy. Defective devices or devices with less than 13 pounds buoyancy shall be removed from service.
- All PFDs shall be equipped with reflective tape as specified in 46 CFR 25.25-15.
- Thirty-inch USCG-approved ring buoys with at least 150 feet of 600-pound capacity line shall be provided and readily available for emergency rescue operations. The distance between ring buoys shall not exceed 200 feet.
- PFD lights conforming to 46 CFR 161.012 shall be required whenever there is a potential need for life rings to be used after dark. Onshore installations, at least one life ring, and every third one thereafter, shall have a PFD light attached. PFD lights on life rings are required only in locations where adequate general lighting (e.g., floodlights or light stanchions) is not provided.

12.1.17.2 Cold Water Work

When the combined air and water temperature is below 90°F, field personnel working on or near water shall wear either a float coat and bib overalls (e.g., a full two-piece "Mustang" survival suit or similar) or a one-piece survival suit. Suits or float coats shall be USCG approved. If extremely cold or severe weather conditions are forecast, work activities should be postponed. Work activities will be continually reviewed and adjustments made if wearing a survival suit during work activities potentially poses a hazard due to warm air temperatures, or limited mobility or agility. In addition, proximity of water work to shore and scope/duration/timing of work activities will be considered when stipulating the above requirement. Overall, if water craft will be used during work, or work will be conducted near water, it is imperative that site-specific conditions are considered and evaluated so that proper safeguards and procedures are in place prior to beginning work.

In addition to considering the use of apparel appropriate for anticipated air, weather, and water conditions, field teams shall identify any procedures necessary for cold-water "man-overboard" scenarios. These procedures should be identified in the site-specific HASP, described in the JSA used for boating activities and, if prudent, practiced before work.

12.1.18 Noise

Excessive noise is hazardous not only because of its potential to damage hearing, but also because of its potential to disrupt communications and instructions. The following procedures and practices shall be followed to prevent noise-related hazards:

- All employees will have access to ear protection with a Noise Reduction Rating of not less than 30.
- Ear protection must be worn in any environment where site personnel must raise their voices to be heard while standing at a distance of 3 feet or less.
- Ear protection must be worn by any personnel observing or operating concrete cutting or sawing equipment, pile driving, or other loud noise-generating activities.

Hearing protection is required for site personnel operating or working near noisy equipment or operations, where the noise level is greater than 85 A-weighted decibels (dbA) (time-weighted average [TWA]), as well as personnel working around heavy equipment. The FL will determine the need and appropriate testing procedures, (i.e., sound level meter and/or dosimeter) for noise measurement.

When needed, a sound level meter will be used to measure noise levels at selected locations in the work area and on the site perimeter. When used, noise monitoring equipment must be calibrated before and after each shift.

If continuous noise levels are found to exceed 85 dbA at any location within the work area, warning signs will be posted. Site personnel and visitors will be notified that hearing protection is required. Appropriate hearing protection (i.e., ear plugs or ear muffs) will be worn whenever personnel or visitors are working in that location. A supply of ear plugs will be maintained on site.

Action levels in Table 12-3 will trigger the use of appropriate hearing protection (plugs or muffs). Hearing protection must be able to attenuate noise below 90 dbA (8-hour TWA). Each hearing protection or device has a Noise Reduction Rating (NRR) assigned by EPA. The calculation for a hearing protection device's effectiveness is:

Equation 1

Noise reading $dbA - (NNR - 7db) < 90dbA$

where:

dbA	=	A-weighted decibel
NRR	=	Noise Reduction Rating

Table 12-3
Noise Exposure Action Levels

Instrument	Measurement	Action
Type I or Type II Sound Level Meter or Dosimeter	> 80 dbA to 85 dbA	Hearing protection recommended. Limit work duration to 8-hour shifts.
	> 85 dbA to 90 dbA	Hearing protection required. Limit work duration to 8-hour shifts.
	> 90 dbA to 115 dbA	Hearing protection required. Investigate use of engineering controls. Limit work duration to 8-hour shifts.
	> 115 dbA	Stop work. Consult SSHO.

12.1.19 Lifting and Material Handling

Observe the following procedures and practices for lifting and material handling:

- Use leather gloves when handling metal, wire rope, sharp debris, or transporting materials (e.g., wood, piping, or drums).
- The size, shape, and weight of the object to be lifted must first be considered. No individual employee is permitted to lift any object that weighs more than 60 pounds. Multiple employees or mechanical lifting devices are required for objects heavier than the 60-pound limit.
- Plan a lift before doing it. Bend at the knees and lift with the legs; maintain the natural curves of the back; do not use back muscles.
- Check the planned route for clearance.
- Use the buddy system when lifting heavy or awkward objects.
- Do not twist your body while lifting.
- Know the capacity of any handling device (e.g., crane, forklift, chain fall, or come-along) that you intend to use.
- Use tag lines to control loads.
- Ensure that your body, material, tools, and equipment are safe from such unexpected movement as falling, slipping, rolling, tripping, bowing, or any other uncontrolled motion.

- Trucks (i.e., flat beds) hauling equipment or materials must not be moved once rigging has been released.
- Chock all material and equipment (such as pipe, drums, tanks, reels, trailers, and wagons) as necessary to prevent rolling.
- Tie down all light, large-surface-area material that might be moved by the wind.
- When working at heights, secure tools, equipment, and wrenches against falling.
- Do not store materials or tools on ducts, lighting fixtures, beam flanges, hung ceilings, or similar elevated locations.
- Fuel-powered tools used inside buildings or enclosures shall be vented and checked for excessive noise.

12.1.20 Fire Control

Observe the following fire control procedures and practices:

- Smoke only in designated areas.
- Keep flammable liquids in closed containers.
- Keep the work site clean; avoid accumulating combustible debris such as paper.
- Obtain and follow property owner hot work safety procedures when welding or performing other activities requiring an open flame.
- Isolate flammable and combustible materials from ignition sources.
- Ensure fire safety integrity of equipment installations according to National Electrical Code specifications.

12.1.21 Static Electricity and Transfer of Flammable Liquids

Observe the following procedures and practices regarding static electricity when transferring flammable liquids:

- Electrically bond and ground pumps, transfer vessels, tanks, drums, bailers, and probes when moving flammable liquids.
- Electrically bond and ground vacuum trucks and the tanks they are emptying.
- Do not splash fill containers with flammable liquids.
- Pour flammable liquids slowly and carefully.
- Two fire extinguishers (2A20:BC) must be available, charged, inspected, and readily accessible.

12.1.22 Cleaning Equipment

Observe the following procedures and practices when cleaning equipment:

- Wear appropriate PPE to avoid skin and eye contact with isopropyl alcohol, Alconox®, or other cleaning materials.
- Stand upwind to minimize any potential inhalation exposure.

- Dispose of spent cleaning solutions and rinses accordingly.

12.2 Environmental Hazards and Controls

12.2.1 Fatigue Management

Because Anchor QEA personnel may be working during both daytime and nighttime hours several days per week, depending on the activity, it is important that all personnel are aware of the hazards related to fatigue. Fatigue can be defined as an increasing difficulty in performing physical or mental activities. Signs of fatigue may include tiredness, changes in behavior, loss of energy, and reduced ability to concentrate. Fatigued site personnel may have a reduced ability to recognize or avoid risks on the work site, which may lead to an increase in the number and severity of injuries and other incidents. Fatigue can occur at any time when working and may cause safety concerns due to decreased manual dexterity, reaction time, and alertness.

Fatigue results from insufficient rest and sleep between activities. Contributing factors to fatigue may include the following:

- The time of day that work takes place
- The length of time spent at work and in work-related duties
- The type and duration of a work task and the environment (e.g., weather conditions and ambient noise) in which it is performed
- The quantity and quality of rest obtained prior to, during, and after a work period
- Non-work activities
- Individual factors such as sleeping disorders, medications, or emotional state

Personnel suffering from fatigue may exhibit both physical and mental effects, such as the following:

- Slower movements
- Poor coordination
- Slower response time to interaction
- Bloodshot eyes
- Slumped or weary appearance
- Nodding off
- Distractedness or poor concentration
- Inability to complete tasks
- Fixed gaze
- Appearing depressed, irritable, frustrated, or disinterested

Employees are strongly encouraged to get sufficient pre-work rest, maintain sufficient nutritional intake during work (i.e., eat and drink at regular intervals), and communicate with team members and leaders if their level of fatigue elevates.

Use the following procedures to help detect and address fatigue-related issues:

- Periodically observe and query coworkers for signs or symptoms of fatigue.
- Site personnel that express concern over their level of fatigue, or that are observed to be fatigued such that elevated worker risk is evident, will be relieved or their work tasks adjusted so that they may rest sufficiently.
- Work schedules will consider fatigue factors and optimize continuous periods available for uninterrupted sleep. The employee is responsible for reporting to work properly rested and fit for duty. In case of an emergency or operational difficulties (e.g., limited access due to water levels or boat repairs), work hours may require adjustment.
- Maintain a routine exercise program and regular sleep schedule as much as possible over the course of the work.
- Avoid heavy meals or caffeine and minimize or eliminate the consumption of alcohol and nicotine before sleeping.

12.2.2 Heat Stress

Observe the following general procedures and practices regarding heat stress:

- Increase the number of rest breaks and/or rotate site personnel in shorter work shifts.
- Watch for signs and symptoms of heat stress and fatigue (see Section 12.2.2.1).
- During hot months, plan work for early morning or evening.
- Use ice vests when necessary.
- Rest in cool, dry areas.
- Ensure that employees have access to potable drinking water and shade.
- During conditions exceeding 95°F, ensure that the following additional procedures are adhered to:
  - Establish effective communication by voice, observation, or electronic means.
  - Observe employees for alertness and signs or symptoms of heat illness.
  - Designate one or more employees on each work site as authorized to call for emergency medical services.
  - Remind employees to drink water throughout the shift.
  - Conduct pre-shift meetings before beginning work to review the high heat procedures, encourage drinking water, and remind employees of their right to take a cool-down rest when necessary.

12.2.2.1 Signs, Symptoms, and Treatment

The FL will be trained in heat stress prevention, including the following, prior to supervising employees:

- Procedures to prevent heat illness.

- Procedures to follow when an employee exhibits symptoms consistent with possible heat illness, including emergency response procedures.

The information provided below addresses these training requirements.

Adverse climatic conditions are important considerations in planning and conducting site operations. High ambient temperature can result in health effects ranging from transient heat fatigue, physical discomfort, reduced efficiency, personal illness, and increased accident probability to serious illness or death. Heat stress is of particular concern when chemical protective garments are worn because they prevent evaporative body cooling. Wearing PPE places employees at considerable risk of developing heat stress.

Heat stress is caused by a number of interacting factors, including environmental conditions, clothing, workload, and the individual characteristics of the worker. Because heat stress is probably one of the most common (and potentially serious) illnesses, regular monitoring and other preventive precautions are vital.

Heat Rash. Heat rash can be caused by continuous exposure to hot and humid air and skin abrasion from sweat-soaked clothing, rubber boots, or impermeable waders. The condition is characterized by a localized red skin rash and reduced sweating. Heat rash reduces the ability to tolerate heat. To treat, keep skin hygienically clean and allow it to dry thoroughly after using chemical protective clothing. Take measures to prevent heat rash by changing clothes often to maximize use of dry garments, or taking frequent breaks to allow doffing of equipment and drying of skin.

Heat Cramps. Heat cramps are caused by profuse perspiration with inadequate electrolytic fluid replacement. This often robs the larger muscle groups (stomach and quadriceps) of blood, which can cause painful muscle spasms and pain in the extremities and abdomen. To treat, move the employee to a cool place and give sips of water or an electrolytic drink. Watch for signs of heat exhaustion or heat stroke.

Heat Exhaustion. Heat exhaustion is a mild form of shock caused by increased stress on various organs to meet increased demand to cool the body. Onset is gradual and symptoms should subside within 1 hour. Symptoms include a weak pulse; shallow breathing; pale, cool, moist skin; profuse sweating; dizziness; and fatigue. To treat, move the employee to a cool place and remove as much clothing as possible. Give sips of water or electrolytic solution and fan the person continuously to remove heat by convection. Do not allow the affected person to become chilled. Treat for shock if necessary.

Heat Stroke. Heat stroke is the most severe form of heat stress; the body must be cooled immediately to prevent severe injury and/or death. ***This is a medical emergency!*** Symptoms include red, hot, dry skin; a body temperature of 105°F or higher; no perspiration; nausea; dizziness and confusion; and a strong, rapid pulse. Because heat stroke is a true medical emergency, transport the patient to a medical facility immediately. Prior to transport, remove as much clothing as possible and wrap the patient in a sheet soaked with water. Fan the patient vigorously while transporting to help reduce body temperature. If available, apply cold packs under the arms, around the neck, or any other place where they can cool large surface blood vessels. If transportation to a medical facility is delayed, reduce body temperature by immersing the patient in a cool-water bath (however, be careful not to over-chill the patient once body temperature is reduced below 102°F). If this is not possible, keep the patient wrapped in a sheet and continuously douse with water and fan.

12.2.2.2 Prevention

The implementation of preventative measures is the most effective way to limit the effects of heat-related illnesses. During periods of high heat, adequate liquids must be provided to replace lost body fluids. Replacement fluids can be a 0.1% saltwater solution, a commercial mix such as Gatorade, or a combination of these with fresh water. The replacement fluid temperature should be kept cool, 50°F to 60°F, and should be placed close to the work area. Employees must be encouraged to drink more than the amount required to satisfy thirst. Employees should also be encouraged to salt their foods more heavily during hot times of the year.

Cooling devices such as vortex tubes or cooling vests can be worn beneath impermeable clothing. If cooling devices are worn, only physiological monitoring will be used to determine work activity.

All site personnel are to rest when any symptoms of heat stress are noticed. Rest breaks are to be taken in a cool, shaded rest area. Employees shall remove chemical protective garments during rest periods and will not be assigned other tasks.

All employees shall be informed of the importance of adequate rest and proper diet, including the harmful effects of excessive alcohol and caffeine consumption.

12.2.2.3 Monitoring

Heat stress monitoring should be performed when employees are working in environments exceeding 90°F ambient air temperature. If employees are wearing impermeable clothing, this monitoring should begin at 77°F. There are two general types of monitoring that the health and safety representative can designate to be used: wet bulb globe temperature (WBGT), and physiological. The Heat Stress Monitoring Record form (see Appendix A) will be used to record the results of heat stress monitoring.

Note that some states such as Washington and California have specific regulatory standards for protection of employees from heat stress-related injuries.

Wet Bulb Globe Temperature (WBGT). The WBGT index is the simplest and most suitable technique to measure the environmental factors that most nearly correlate with core body temperature and other physiological responses to heat. When WBGT exceeds 25°C (77°F), the work regiment in Table 12-4 should be followed.

Table 12-4
Permissible Heat Exposure Threshold Limit Values

Work/Rest Regimen	Workload		
	Light	**Moderate**	**Heavy**
Continuous work	86°F (30.0°C)	80°F (26.7°C)	77°F (25.0°C)
75% work, 25% rest each hour	87°F (30.6°C)	82°F (28.0°C)	78°F (25.9°C)
50% work, 50% rest, each hour	89°F (31.4°C)	85°F (29.4°C)	82°F (27.9°C)
25% work, 75% rest, each hour	90°F (32.2°C)	88°F (31.1°C)	86°F (30.0°C)
These TLVs assume that nearly all acclimated, fully-clothed site personnel with adequate water and salt intake should be able to function effectively under the given working conditions without exceeding a deep body temperature of 100.4°F (38°C).			

Note:
Source: OSHA Technical Manual, Section III: Chapter 4 – Heat Stress

The TLVs denoted in Table 12-4 apply to physically fit and acclimatized individuals wearing light, summer clothing. If heavier clothing that impedes sweat or has a higher insulation value is required, the permissible heat exposure TLVs should be adjusted based on the WBGT Correction Factors in Table 12-5.

Table 12-5
Wet Bulb Globe Temperature Correction Factors

Clothing Type	WBGT Correction
Summer lightweight working clothing	0°F (0°C)
Cotton coveralls	-3.6°F (-2°C)
Winter work clothing	-7.2°F (-4C)
Water barrier, permeable	-10.8°F (-6°C)
Fully encapsulating	-14.4°F (-10°C)

Physiological. Physiological monitoring can be used in lieu of, or in addition to, WBGT. This monitoring can be self-performed once the health and safety representative demonstrates appropriate techniques to affected employees. Because individuals vary in their susceptibility to heat, this type of monitoring has its advantages. The following two parameters are to be monitored at the beginning of each rest period:

- **Heart Rate:** The maximum heart rate (MHR) is the amount of work (beats) per minute a healthy person's heart can be expected to safely deliver. Each individual will count his/her radial (wrist) pulse for 1 minute as early as possible during each rest period. If the heart rate of any individual exceeds 75% of his/her calculated MHR (MHR = 200 - age) at the beginning of the rest period, then the work cycle will be decreased by one-third. The rest period will remain the same. An individual is not permitted to return to work until his/her sustained heart rate is below 75% of his/her calculated MHR.
- **Temperature:** Each individual will measure his/her temperature with a thermometer for 1 minute as early as possible in the first rest period. If the temperature exceeds 99.6°F at the beginning of the rest period, then the work cycle will be decreased by one-third. The rest period will remain the same. An individual is not permitted to return to work if his/her temperature exceeds 100.4°F.

12.2.2.4 Training

Employees potentially exposed to heat stress conditions will be instructed on the contents of this procedure. This training can be conducted during daily tailgate safety meetings.

12.2.3 Cold Stress

Observe the following procedures and practices regarding cold stress:

- Take breaks in heated shelters when working in extremely cold temperatures.
- Upon entering the shelter, remove the outer layer of clothing and loosen other layers to promote evaporation of perspiration.
- Drink warm liquids to reduce the susceptibility to cold stress.
- Be aware of cold stress symptoms, including shivering, numbness in the extremities, and sluggishness.
- Provide adequate insulating dry clothing to maintain warmth if work is performed in air temperature below 40°F. Wind chill cooling rates and the cooling power of air are critical factors. The higher the wind speed and the lower the temperature in the work area, the greater the insulation value of the protective clothing required.
- If the air temperature is 32°F or less, hands should be protected.
- If only light work is involved and if the clothing on the worker may become wet on the job site, the outer layer of the clothing in use should be impermeable to water. With more severe work under such conditions, the outer layer should be water repellent, and the outer wear should be changed as it becomes wetted. The outer garments should include provisions for easy ventilation in order to prevent wetting of the inner layer by sweat.

- If available clothing does not give adequate protection to prevent cold injury, work should be modified or suspended until adequate clothing is made available, or until weather conditions improve.
- Implement a buddy system in which site personnel are responsible for observing fellow workers for early signs and symptoms of cold stress.

12.2.3.1 Signs, Symptoms, and Treatment

Cold stress can range from frostbite to hypothermia. The signs and symptoms of cold stress are listed below. The appropriate guidelines should be followed if any personnel exhibit these symptoms:

Frostbite. Frostbite is characterized by pain in the extremities and loss of manual dexterity. "Frostnip," or reddening of the tissue, is accompanied by a tingling or loss of sensation in the extremities and continuous shivering.

Hypothermia. Hypothermia is characterized by pain in the extremities and loss of manual dexterity, with severe, uncontrollable shivering, and an inability to maintain the level of activity. Symptoms include excessive fatigue, drowsiness, irritability, or euphoria. Severe hypothermia includes clouded consciousness, low blood pressure, pupil dilation, cessation of shivering, unconsciousness, and possible death.

Move the patient to a warm, dry place. If the patient's clothing is wet, remove it and replace it with dry clothing. Keep the patient warm. Re-warming of the patient should be gradual to avoid stroke symptoms. Dehydration, or the loss of body fluids, may result in a cold injury due to a significant change in blood flow to the extremities. If the patient is conscious and alert, warm sweet liquids should be provided. Coffee and other caffeinated liquids should be avoided because of diuretic and circulatory effects. Extremities affected by frostbite should be gradually warmed up and returned to normal temperature. Moist compresses should be applied; begin with lukewarm compresses and slowly increase the temperature as changes in skin temperature are detected. Keep the patient warm and calm and move them to a medical facility as soon as possible.

12.2.4 Sunlight and Ultraviolet Exposure

Observe the following procedures and practices regarding ultraviolet (UV) exposure:

- Protect against extended exposure to sunlight with shade, long clothing, sunscreen, and high-SPF, broad-spectrum sunscreen applied frequently.
- Plan work to avoid unnecessary UV exposure (see Section 12.2.2.2).
- During peak daylight months, plan work for early morning or evening.
- Many factors affect the hazards associated with UV exposure, including the following:
  - **Time of day:** UV rays are strongest between 10:00 a.m. and 4:00 p.m.

  - **Season of the year:** UV rays are stronger during spring and summer months. This is less of a factor near the equator.
  - **Distance from the equator (latitude):** UV exposure goes down as you get farther from the equator.
  - **Altitude:** More UV rays reach the ground at higher elevations.
  - **Cloud cover:** The effect of clouds can vary. Sometimes cloud cover blocks some UV from the sun and lowers UV exposure, while some types of clouds can reflect UV and increase UV exposure. What is important to know is that UV rays can get through, even on a cloudy day.
  - **Reflection off surfaces:** UV rays can bounce off surfaces like water, sand, snow, pavement, or grass, leading to an increase in UV exposure.
- Cloud cover does not necessarily protect from UV exposure. Consider monitoring the UV index for your work area: http://www2.epa.gov/sunwise/uv-index.
- Evaluate site-specific factors affecting UV exposure and address work practices as appropriate.

12.2.4.1 Signs, Symptoms, and Treatment

The best way to treat sunburn is to prevent it using the guidelines listed in the bullets in the prior subsection and in Section 12.2.2.2. Signs of sunburn include the following:

- Pinkness or redness
- Skin that feels warm or hot to the touch
- Pain, tenderness, or itching
- Swelling
- Small, fluid-filled blisters, which may break
- Headache, fever, chills, and fatigue if the sunburn is severe

If signs of sunburn are noticed, avoid further exposure and immediately implement treatment. If the sunburn is blistering *and* covers 15% or more of the body, seek medical attention.

12.2.4.2 Prevention

UV exposure hazards and their impacts on each worksite should be evaluated to determine the best practices for risk mitigation. The most effective way to prevent skin damage from UV exposure is to protect bare skin from the exposure. This can be accomplished with shade, clothing (e.g., pants, long sleeves, or hats), sunscreen, and sunglasses. Plan work to either create shade or take advantage of natural shade, and avoid peak UV times during the day when possible.

12.2.5 Inclement Weather

Observe the following procedures and practices regarding inclement weather:

- Evaluate the worksite for hazards that may be amplified during inclement weather, such as traction issues, ingress and egress, slope stability, or wind-driven hazards (e.g., dust, debris, or falling trees).
- Stop outdoor work during electrical storms (lightning strikes), hailstorms, high winds, and other extreme weather conditions such as extreme heat or cold.
- Take cover indoors or in a vehicle that will provide adequate protection. In some cases, this may require exiting the worksite, such as during windstorms in areas with overhead hazards (e.g., trees or power lines).
- Listen to local forecasts for warnings about specific weather hazards such as tornadoes, hurricanes, and flash floods.
- Verify that on-site equipment and resources are adequately protected from inclement weather.
- If working in an unfamiliar geographic location, consult with local resources for unique weather hazards.

12.2.6 Insects/Spiders

Observe the following general procedures and practices regarding insects/spiders:

- Tuck pants into socks.
- Wear long sleeves.
- Use insect repellent.
- Avoid contact by always looking ahead to where you will be walking, standing, sitting, leaning, grabbing, lifting, or reaching.
- Check for signs of insect/spider bites, such as redness, swelling, and flu-like symptoms.

The most dangerous spiders to humans in North America are black widows and brown spiders (also known as brown recluse or fiddleback spiders). A guide to identifying these spiders is presented in Table 12-6.

Table 12-6
North American Hazardous Spider Identification Guide

Hazardous Spider Identification Guide	
Black Widow Spider • Abdomen usually shows hourglass marking • Female is 3 to 4 centimeters in diameter • Have been found in well casings and flush-mount covers • Not aggressive, but more likely to bite if guarding eggs • Light, local swelling and reddening are early signs of a bite, followed by intense muscular pain, rigidity of the abdomen and legs, difficulty breathing, and nausea • If bitten, see a physician as soon as possible	
Brown Spiders (aka Brown Recluse or Fiddleback) • Found in the central and southern United States, although in some other areas, as well • 1/4-to-1/2-inch-long body, and size of a silver dollar • Hide in baseboards, ceiling cracks, and undisturbed piles of material • Bite may either go unnoticed or may be followed by a severe localized reaction, including scabbing, necrosis of the affected tissue, and very slow healing • If bitten, see a physician as soon as possible	

12.2.7 Bees and Wasps

Many encounters with bees and wasps occur when nests built in well casings or excavation areas are disturbed. Before opening a well casing, take a few moments to observe whether or not insects are entering or exiting. If they are flying to and from the casing, avoid it if possible. If you must be in an area where disturbing a nest is likely, be sure to wear long pants and a long-sleeved shirt. Stinging insects fly around the top of their target, so if you get into trouble, pull a portion of your shirt over your head and run away.

If you get stung, look for a stinger and, if present, remove it as soon as possible. Several over-the-counter products or a simple cold compress can be used to alleviate the pain of the sting. If the sting is followed by severe symptoms, or if it occurs in the neck or the mouth, seek medical attention immediately because swelling could cause suffocation.

If you need to destroy a nest, consult with the PM and project FL first. Commercially available stinging insect control aerosols are very effective, but could potentially contaminate the well. Once the nest is destroyed, fine mesh may be applied over the exit and entry points of a well casing to prevent re-infestation.

12.2.8 Ticks

Ticks in North America can be carriers of several diseases, including Lyme's Disease, Rocky Mountain Spotted Fever, and ehrlichiosis.

Limiting exposure to ticks reduces the likelihood of infection when exposed to tick-infested habitats. Measures to prevent tick exposure include the following:

- Remove leaf litter and brush in areas where you will be working prior to tick season.
- Wear light-colored clothing so that ticks are visible.
- Tuck your pant legs into your socks.
- Apply repellents to discourage tick attachment.
- Promptly inspect your body and remove crawling or attached ticks when you leave a tick-infested area.
- Conduct tick checks on buddies upon exiting any suspect area (may be needed multiple times per work day).
- Be aware of seasonal activity; ticks are often most active in the spring.

Observe the following procedures and practices if you are bitten by a tick:

- Use fine-tipped tweezers or shield your fingers with tissue, paper towel, or rubber gloves.
- Grasp the tick as close to the skin surface as possible and pull upward with steady, even pressure. Do not twist or jerk the tick; this may cause mouthparts to break off and remain in the skin.
- Do not squeeze, crush, or puncture the body of the tick because its fluids may contain infectious organisms.
- Do not handle the tick with bare hands because infectious agents may enter through mucous membranes or breaks in the skin.
- After removing the tick, thoroughly disinfect the bite site and wash your hands with soap and water.
- You may wish to save the tick for identification in case you become ill within 2 to 3 weeks. Place the tick in a sealed plastic bag in the freezer, and mark the bag with the date of the bite.

12.2.9 Mosquitoes

Mosquitoes in the United States have been known to carry West Nile virus, Zika virus, St. Louis encephalitis, and Dengue fever. Avoid mosquito bites by doing the following:

- Apply insect repellent containing DEET (N,N-diethyl-meta-toluamide) when outdoors. DEET is very effective, but could potentially contaminate samples.
- Read and follow the product directions whenever you use insect repellent.

- Wear long-sleeved clothes and long pants treated with repellent to further reduce your risk, or stay indoors during peak mosquito feeding hours (dusk until dawn).
- Limit the number of places available for mosquitoes to lay their eggs by eliminating standing water sources from around the work area.
- If you need to destroy a nest, consult with the PM and project FL first.
- Check to see if there is an organized mosquito control program near the project site. If no program exists, work with the local government officials to establish a program.

12.2.10 Bird Droppings

Large populations of roosting birds may present a disease risk. The most serious health risks arise from disease organisms that grow in the accumulations of bird droppings, feathers, and debris under a roost—especially if roosts have been active for years. Among the fungal diseases associated with bird droppings, the two most common are Histoplasmosis and Cryptococcosis.

If you are working in an area where large quantities of droppings are present, follow certain precautions to minimize the risk from disease organisms in the droppings:

- Wear a respirator that can filter particles as small as 0.3 microns, such as a HEPA filter.
- Wear disposable protective gloves, hat, coveralls, and boots if you will be in close contact.
- Wash or shower at the work site after cleanup, if possible.
- If allowable, modify the structure or use methods to prevent birds from re-establishing the roost.

12.2.11 The Public at Large

The community residents around worksites may pose their own specific hazards. These conditions may include the following:

- Unintentional disruption of work
- Benign or malicious trespass
- Criminal intent

Scenarios may include the following:

- Pedestrians, cyclists, or motorists disregarding site boundaries due to distraction or willful disobedience.
- Public use of private site facilities for shelter, relief, and other reasons with no ill-intention.
- Public use of private site facilities for mischievous or criminal activity, such as loitering, vandalism, or theft.
- Encounters with community members who are disgruntled with the project activity.
- Encounters with criminal activities on or near a project site.

If any of the above are anticipated to be likely, take the following precautions as appropriate:

- Verify that the site is adequately marked and barricaded to limit unintentional disruptions of the work by the public.
- Review the site for attractive nuisances (e.g., hazards or conditions that are likely to attract children), and mitigate those.
- Secure all equipment and site facilities to prevent unauthorized access or use.
- Remove valuable items from the site or adequately secure them on site to limit the temptation for potential criminals.
- Have contact information for the client's or owner's public relations office while on site, and direct disgruntled community members to that office. If necessary, vacate the site to relieve the situation and notify the PM or FL.
- Work in pairs when uncertain of the public safety situation at a site. In questionable situations, postpone work as necessary until a plan of action can be developed to verify a safe working environment.

12.2.12 Personal Health and Safety

In addition to hazards associated with chemicals of concern, equipment, operations or site conditions discussed above, there may be additional personal safety issues to consider at a site, including those related to one or multiple protected classes, such as race, gender, religion, ability, sexual orientation, or gender identity. These conditions may involve the following, perpetrated by the public or those associated with the work:

- Malicious disruption of work
- Harassment, including unwanted comments, gestures, or actions
- Threats of violence, either implied (using derogatory language) or explicit
- Assault

<u>It is critical that the work environment be discussed within the project team to evaluate risks, ways to avoid those risks, and communication protocols. Anchor QEA requires that work be performed in teams.</u>

Specifically, if any of the above are anticipated, take the following precautions as appropriate:

- Alert the PM, FL, SSHO, and/or Human Resources Department of potential issue(s).
- Formulate a plan of action to verify and maintain a safe working environment prior to field work, which may include the following:
  - Working in pairs and/or within a certain physical distance of other work groups.
  - Coordinated check-ins (calls to or from the office or visual check-ins with other field members).

- Whenever possible, schedule work only within daylight hours (which fluctuate seasonally) or on weekends when questionable scenarios may be more minimal.
  - If night work is required, maintain a minimum of two field personnel at all times, and potentially increase the total number of personnel.
  - If working in high-risk areas, discuss the possibility of hiring security if work needs to be performed at night, in low light, or near potentially dangerous areas (e.g., abandoned buildings, public displays of hostility, discrimination, or gang-related activity).
- Maintain a field phone with active GPS and non-locking 911 capability at all times while out in the field.
- If a need arises for a change in field work (e.g., additional sampling or moving to an area that was not planned) or travel plans (e.g., dead battery or flat tire), immediately alert the FL and PM as to the event.

In addition, practice active awareness of your environment. Discuss personal health and safety concerns at the daily tailgate meeting. If you feel unsafe based on the potential behavior of others, immediately bring it up to field team coworkers. If the issue is not resolved to your satisfaction, alert the PM, FL, SSHO, and/or Human Resources Department to assist in resolving any potential issue(s).

13 Medical Surveillance Program

This section describes the medical surveillance program that Anchor QEA field personnel must comply with when working on sites where there is a potential for exposure to hazardous wastes or other hazardous substances.

13.1 General Requirements

Anchor QEA employees shall be enrolled in a medical surveillance program in compliance with OSHA standards (29 CFR 1910.120(f)) under the following circumstances.

If they are involved with any of the following operations:

- *Cleanup operations* required by a governmental body, whether federal, state, local, or other involving hazardous substances that are conducted at uncontrolled hazardous waste sites (including, but not limited to, the EPA's National Priority List [NPL] sites, state priority list sites, sites recommended for the EPA NPL, and initial investigation of government-identified sites that are conducted before the presence or absence of hazardous substances has been ascertained)
- *Corrective actions* involving cleanup operations at sites covered by the Resource Conservation and Recovery Act of 1976 (RCRA) as amended (42 United States Code 6901 et seq)
- *Voluntary cleanup operations* at sites recognized by federal, state, local, or other governmental bodies as uncontrolled hazardous waste sites
- *Operations involving hazardous wastes* that are conducted at treatment, storage, and disposal facilities regulated by 40 CFR 264 and 40 CFR 265 pursuant to RCRA or by agencies under agreement with the EPA to implement RCRA regulations
- *Emergency response operations* for releases of, or substantial threats of releases of, hazardous substances without regard to the location of the hazard

And, if they meet the following criteria:

- Are or may be exposed to hazardous substances or health hazards at or above the established PEL, above the published exposure levels for these substances, without regard to the use of respirators, for 30 days or more per year

In addition, employees are required to be enrolled in the medical surveillance program if they meet any of the following conditions:

- Wear a respirator for 30 days or more per year
- Are injured, become ill, or develop signs or symptoms due to possible overexposure involving hazardous substances or health hazards from an emergency response or hazardous waste operations

- Are members of a Hazardous Materials (HAZMAT) team

Anchor QEA employees required to be enrolled in a medical surveillance program under 29 CFR 1910.120(f) shall have medical examinations and consultations made available to them by Anchor QEA on the following schedule:

- Prior to assignment
- At least once every 12 months unless the attending physician believes a longer interval (not greater than biennially) is appropriate
- At termination of employment or reassignment to an area where the employee would not be covered if the employee has not had an examination within the last 6 months
- As soon as possible upon notification that the employee has developed signs or symptoms indicating possible overexposure to hazardous substances or health hazards, or that the employee has been injured or exposed above the PEL or published exposure levels in an emergency situation
- At more frequent times, if the examining physician determines that an increased frequency of examination is medically necessary

The content of medical examinations or consultations made available to employees shall be determined by the attending physician but shall include, at a minimum, a medical and work history with special emphasis on symptoms related to the handling of hazardous substances and health hazards, and to fitness for duty including the ability to wear any required PPE under conditions (i.e., temperature extremes) that may be expected at the work site.

The attending physician shall provide Anchor QEA with a written opinion for each examined employee that contains the following information:

- Whether the employee has any detected medical conditions that would place the employee at an increased risk of impairment of the employee's health from hazardous waste operations work, emergency response, or respirator use
- Any recommended limitations on the employee's assigned work
- A statement that the employee has been informed of the results of the medical examination and any medical conditions that require further examination or treatment

The written opinion obtained by Anchor QEA shall not reveal specific findings or diagnoses unrelated to occupational exposures. Medical surveillance and other employee-related medical records shall be retained for at least the duration of employment plus 30 years.

13.2 Team Self-Monitoring

All personnel will be instructed to look for and inform each other of any deleterious changes in their physical or mental condition during the performance of all field activities. Examples of such changes are as follows:

- Headaches
- Dizziness
- Nausea
- Blurred vision
- Cramps
- Irritation of eyes, skin, or respiratory system
- Skin chafing from damp or wet clothing
- Changes in complexion or skin color
- Changes in apparent motor coordination
- Increased frequency of minor mistakes
- Excessive salivation or changes in papillary response
- Changes in speech ability or speech pattern
- Symptoms of heat stress or heat exhaustion
- Symptoms of hypothermia

If any of these conditions develop, the affected person will be moved from the immediate work location and evaluated. If further assistance is needed, personnel at the local hospital will be notified, and an ambulance will be summoned if the condition is thought to be serious. If the condition is the result of sample collection or processing activities, procedures and/or PPE will be modified to address the problem.

Appendix A
Health and Safety Logs and Forms

Daily Air Monitoring Record

Project Name: ______________________ **Date:** ______________________

Project Number: ______________________ **Location:** ______________________

Temperature: ______________________

Conditions: ______________________

COC	Instrument	S/N	Calibration Date	Calibration Gas/Method	Calibration by
Organic vapors					
Particulates					
O_2					
Other:					
Other:					
Other:					

Time	Location/Description	Organic Vapor (ppm)	O2%	CG %LEL	Other	Other

Notes:

Completed by:

Printed Name Signature Date

Daily Safety Briefing Form

ANCHOR QEA

Date: ______________________

Project No: ______________________

Project Name: ______________________

Person Conducting Meeting: ______________ **Health & Safety Officer:** ______________ **Project Manager:** ______________

TOPICS COVERED:

- ☐ Emergency Procedures and Evacuation Route
- ☐ Directions to Hospital
- ☐ HASP Review and Location
- ☐ Safety Equipment Location
- ☐ Proper Safety Equipment Use
- ☐ Employee Right-to-Know/ SDS Location
- ☐ Fire Extinguisher Location
- ☐ Eye Wash Station Location
- ☐ Buddy System
- ☐ Self and Coworker Monitoring
- ☐ Lines of Authority
- ☐ Communication
- ☐ Site Security
- ☐ Vessel Safety Protocols
- ☐ Work Zones
- ☐ Vehicle Safety and Driving/ Road Conditions
- ☐ Equipment Safety and Operation
- ☐ Proper Use of PPE
- ☐ Decontamination Procedures
- ☐ Near Miss Reporting Procedures
- ☐ Lifting Techniques
- ☐ Slips, Trips, and Falls
- ☐ Hazard Exposure Routes
- ☐ Heat and Cold Stress
- ☐ Overhead and Underfoot Hazards
- ☐ Chemical Hazards
- ☐ Flammable Hazards
- ☐ Biological Hazards
- ☐ Eating/Drinking/Smoking
- ☐ Reviewed Prior Lessons Learned
- ☐ Field Team Medical Conditions for Emergency Purposes (Confidential): ______________
- ☐ Other: ______________

Weather Conditions: ______________

Daily Work Scope: ______________

Site-specific Hazards: ______________

Safety Comments: ______________

Attendees

Printed Name	Signature

End of Day Wellness Check

PLAYING IT SAFE

Modification to Health and Safety Plan

Date: ______________________________

Project No: ______________________________

Project Name: ______________________________

Modification: ______________________________

____

____

____

____

Reason for Modification: ______________________________

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Site Personnel Briefed

Name: ______________________ **Date:** ______________

Name: ______________________ **Date:** ______________

Name: ______________________ **Date:** ______________

Name: ______________________ **Date:** ______________

Name: ______________________ **Date:** ______________

Name: ______________________ **Date:** ______________

Name: ______________________ **Date:** ______________

Name: ______________________ **Date:** ______________

Name: ______________________ **Date:** ______________

Name: ______________________ **Date:** ______________

Name: ______________________ **Date:** ______________

Approvals

Field Lead:	______________	______________	________
	Printed Name	Signature	Date
Project Manager:	______________	______________	________
	Printed Name	Signature	Date

Heat Stress Monitoring Record

Date: ____________________

Project No: ____________________

Project Name: ____________________

Location: ____________________

Employee Name	Monitoring Results												
	Initial Reading Time:	First Work Period Time:		Second Work Period Time:		Third Work Period Time:		Fourth Work Period Time:		Fifth Work Period Time:		Sixth Work Period Time:	
	WBGT (°F):	WBGT (°F):		WBGT (°F):		WBGT (°F):		WBGT (°F):		WBGT (°F):		WBGT (°F):	
	Air Temp (°F):	Air Temp (°F):		Air Temp (°F):		Air Temp (°F):		Air Temp (°F):		Air Temp (°F):		Air Temp (°F):	
	Initial Temp:	Initial Temp:	Final Temp:	Initial Temp:	Final Temp:	Initial Temp:	Final Temp:	Initial Temp:	Final Temp:	Initial Temp:	Final Temp:	Initial Temp:	Final Temp:
	Initial H.R.:	Initial H.R.:	Final H.R.:	Initial H.R.:	Final H.R.:	Initial H.R.:	Final H.R.:	Initial H.R.:	Final H.R.:	Initial H.R.:	Final H.R.:	Initial H.R.:	Final H.R.:
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Notes:

Completed by:

Printed Name ____________________ Signature ____________________ Date ____________________

Utility Contact Prevention Checklist

NOTE: Utility mark-out requirements vary from state to state; consult state authorities before beginning work.

Purpose: This form is intended to help the Field Lead confirm that underground or overhead utilities are identified to the extent practicable and consistent with applicable regulations **PRIOR** to site work.

INVESTIGATIONS MUST NOT OCCUR UNTIL MULTIPLE LINES OF EVIDENCE INDICATE THAT SUBSURFACE OR OVERHEAD UTILITIES ARE NOT PRESENT IN THE WORK AREA

Project Name/No: ____________________ **Date:** ____________________

Field Lead: ____________________ **Project Address:** ____________________

Project Manager: ____________________ **Health & Safety Officer:** ____________________

Emergency Contact Information for One Call: ____________________

Duration/Summary of Work to be Performed: ____________________

____

____

Consideration	Check		Explanation	Initial
Has the state One Call been contacted?	☐ Yes	☐ No		
Has the property owner or client been contacted for local knowledge of utilities, as applicable?	☐ Yes	☐ No		
Does the property owner or client have specific utility contact prevention procedures and, if so, have they been completed?	☐ Yes	☐ No		
Are any as-built drawings available? If so, do they show any utilities?	☐ Yes	☐ No		
Has a visual inspection of the work area(s) been completed?	☐ Yes	☐ No		
Has the potential presence of in-water utilities been assessed (shore markers, streets dead-ending at water's edge, etc.)	☐ Yes	☐ No		
Is evidence of electrical utilities present? (electric meters on structures, conduits, overhead lines, light poles, etc.)	☐ Yes	☐ No		
Is evidence of water/sewer utilities present? (water meter, hydrants, restrooms, grates in ground, etc.)	☐ Yes	☐ No		
Is evidence of telecommunications utilities present? (fiber optic warning signs, conduits from utility poles, wall-mounted boxes, etc.)	☐ Yes	☐ No		
Is other evidence of utilities present? (unknown ground markings, manholes or valve covers, "Call Before You Dig" signs, linear asphalt or concrete repair characteristics, liner subsidence of ground surface, pin flags or stakes, etc.)	☐ Yes	☐ No		

Utility Contact Prevention Checklist

NOTE: Utility mark-out requirements vary from state to state; consult state authorities before beginning work.

Consideration	Check		Explanation	Initial
Has a private locating service been contacted?	☐ Yes	☐ No		
Were any utilities identified and marked out through a private locating service? If so, duplicate mark-outs on site drawings.	☐ Yes	☐ No		
Are there any fiber optic cables, fuel lines, or high-pressure lines within 50 feet of work locations?	☐ Yes	☐ No		
If fiber optic cables, fuel lines, or high-pressure lines are within 50 feet, has an agreement with the utility owner been established?	☐ Yes	☐ No		
Can a test borehole be advanced by hand digging, probing, post-hole digging, and/or air knifing to 5 feet below ground surface (bgs)?	☐ Yes	☐ No		
If hand digging, probing, post-hole digging, and/or air knifing to 5 feet bgs is not possible, can a non-invasive geophysical investigation be conducted? If not, why?	☐ Yes	☐ No		
Other considerations:				

NOTE: Please fill in second page and attach additional reports, drawings, or other information, as necessary.

Confirmation Number: ______________________

Contact Name: ______________ **Organization:** ______________

Contact Date: ______________ **Contact Time:** ______________

Response: ______________________

Completed by:

Printed Name — Signature — Date

Contractor:

Printed Name — Signature — Date

Appendix B
Job Safety Analysis Documents

Job Safety Analysis

Field Activities

Project Name: Pre-Design Data Gaps Sampling	**Project Number:** 000029-02.56	**JSA Number:** 001	**Issue Date:**
Location: Portland, Oregon	**Contractor:** Anchor QEA, LLC	**Analysis by:** Christopher R. Torell P.G., CSP	**Analysis Date:** May 2, 2018
Work Operation: Field activities	**Superintendent/Competent Person:** To Be Determined	**Revised by:**	**Revised Date:**
Required PPE: • Modified Level D—Standard work uniform/coveralls, work boots conforming to ASTM F2412-05, traffic safety vest conforming to ANSI 107, safety glasses conforming to ANSI Z87.1 with permanently installed side shields, hard hat conforming to ANSI Z89, hearing protection • Depending on activity, the following PPE may also be required (see Section 5 of HASP): N95 dust mask, PFD, cold water clothing, disposable chemical coveralls, inner and outer gloves		**Reviewed by:** Ben Johnson **Approved by:** Nik Bacher	**Reviewed Date:** **Approved Date:**

Work Activity	Potential Hazards	Preventive or Corrective Measures	Inspection Requirements
If boating		• Follow the JSA for boating activities.	
Outdoor, physical activity	Slips, trips, and falls	• Be aware of potentially slippery surfaces and tripping hazards. • Use handrails where available. • Wear footwear that has sufficient traction. • Maintain good housekeeping practices. • Clean up all spills immediately. • Be aware of weather effects on the work area, including wet and/or frozen ground. • Jumping, running, and horseplay are prohibited. • Keep all areas clean and free of debris to prevent any trips and falls. • Be aware of and limit loose clothing or untied shoelaces that may contribute to slips, trip, and falls. • Notify the field team members of any unsafe conditions.	• Routinely inspect work area for unsafe conditions.

Job Safety Analysis

Field Activities

Work Activity	Potential Hazards	Preventive or Corrective Measures	Inspection Requirements
Outdoor, physical activity (continued)	Heat stress	• Adjust work schedules, as necessary, to avoid the hottest part of the day. • Take rest breaks as warranted. • Provide shelter (air-conditioned, if possible) or shaded areas to protect personnel during rest periods. • Maintain body fluids at normal levels. • Train workers to recognize the symptoms of heat-related illness.	• Review weather forecast prior to field work. • Monitor workers' physical conditions. • Monitor outside temperature versus worker activity.
	Cold stress	• Provide shelter (enclosed, heated environment) to protect personnel during rest periods. • Educate workers to recognize the symptoms of frostbite and hypothermia. • Use appropriate cold-weather gear, up to and including Mustang-type bib coveralls or jacket/bib combinations. • Consider additional precautions if working near water in cold weather. • Have a dry change of clothing available. • Train workers to recognize the symptoms of cold-related illness.	• Review weather forecast prior to field work. • Monitor workers' physical conditions and PPE. • Monitor outside and water temperature versus worker activity and PPE.
	Rain/snow	• Wear appropriate PPE (rain gear). • Be aware of slip hazards, puddles, and electrical hazards when working in wet conditions. • If extremely cold conditions are forecast, consider additional precautions or postponing work activity.	• Review weather forecast prior to field work. • Inspect PPE daily prior to use. • Routinely inspect work area for deteriorating conditions.
	Sunshine	• Have sunscreen available for ultraviolet protection. • Have abundant water available to prevent dehydration. • Consider wearing wide-brimmed headwear and light-colored, lightweight, sun-blocking clothing.	• Ensure that sunscreen and water are available.
	Lightning	• Do not begin or continue work until lightning subsides for at least 20 minutes. Disconnect and do not use or touch electronic equipment. • Immediately head for shore if on the water and lightning is observed. If not able to get to shore, disconnect and do not use or touch the major electronic equipment, including the radio, throughout the duration of the storm.	• Obtain weather forecast and updates as needed.

Job Safety Analysis

Field Activities

Work Activity	Potential Hazards	Preventive or Corrective Measures	Inspection Requirements
Outdoor, physical activity (continued)	High winds	• Wear goggles or safety glasses if dust or debris are visible.	• Review weather forecast prior to field work. • Ensure that goggles or safety glasses are available.
	Biological hazards (flora [e.g., poison ivy and poison oak] and fauna [e.g., ticks, bees, spiders, and mosquitoes])	• Be aware of likely biological hazards in the work area. • Wear appropriate clothing (i.e., hat, long-sleeve shirt, long pants, leather gloves, boots, and Tyvek coveralls, as appropriate), and apply insect repellant. • Wear hand and arm protection when clearing plants or debris from the work area. • Be aware of potential wildlife and defensive behavior (e.g., nesting birds, or animals with young).	• Ensure that insect repellent is available. • Inspect clothing and skin for insects (e.g., ticks) after working in insect-prone areas.
	Noise exposure	• Wear hearing protection in high noise environments or when working around heavy machinery or equipment (action level of 85 decibels averaged over an 8-hour day).	• Ensure that hearing protection is available.

Training Requirements:

- All personnel working on hazardous waste sites must receive appropriate training as required by 29 CFR 1910.120(e), including but not limited to initial 40-hour, 8-hour supervisor, and annual 8-hour refresher trainings.
- Medical clearance must be received on an annual basis as required by 29 CFR 1910.120(f).
- If boating is involved, and a professional captained vessel is not in use, boat operators must take the appropriate state boater safety courses.
- All assigned employees are required to familiarize themselves with the contents of this JSA before starting a work activity and review it with their supervisor during their daily safety meeting.

Job Safety Analysis

Sediment Sampling

Project Name: Pre-Design Data Gaps Sampling	**Project Number:** 000029-02.56	**JSA Number:** 002	**Issue Date:**
Location: Portland Oregon	**Contractor:** Anchor QEA, LLC	**Analysis by:** Christopher R. Torell P.G., CSP	**Analysis Date:** May 3, 2018
Work Operation: Sediment sampling	**Superintendent/Competent Person:** To Be Determined	**Revised by:**	**Revised Date:**
Required PPE: • Modified Level D—Standard work uniform/coveralls, work boots conforming to ASTM F2412-05, traffic safety vest conforming to ANSI 107, safety glasses conforming to ANSI Z87.1 with permanently installed side shields, hard hat conforming to ANSI Z89, hearing protection • Depending on activity, the following PPE may also be required (see Section 5 of HASP): N95 dust mask, PFD, cold water clothing, disposable chemical coveralls, inner and outer gloves		**Reviewed by:** Ben Johnson **Approved by:** Nik Bacher	**Reviewed Date:** **Approved Date:**

Work Activity	Potential Hazards	Preventive or Corrective Measures	Inspection Requirements
If boating		• Follow the JSA for boating activities.	
If using glassware		• Follow the JSA for handling glassware.	
Sediment sample retrieval and processing	Injury from hand and power tool operation (e.g., spatula or drill)	• Be aware of sharp edges on hand tools (e.g., spatulas, knives, drill bits, and saw blades). • Be aware of electrical connections and water hazards when working with electric- or battery-operated tools. • Ensure that all tools are working properly; repair or replace defective tools. Repair when unplugged and off. • Keep guards on power tools when not in use.	• Inspect tools to ensure that they are in good working order. • Inspect electrical connections (if applicable). • Inspect tools periodically to ensure dry and clean operation.
	Noise exposure	• Wear hearing protection in high noise environments or when working around heavy machinery or equipment (action level of 85 decibels averaged over an 8-hour day).	• Ensure that hearing protection is available.

Job Safety Analysis

Sediment Sampling

Work Activity	Potential Hazards	Preventive or Corrective Measures	Inspection Requirements
Sediment sample retrieval and processing (continued)	Slips, trips, and falls	• Be aware of potentially slippery surfaces, including boat decks, riprap, muddy or algae-covered rocks, shoreline plants/seaweed, thick mud, and tripping hazards. • Use handrails where available. • Wear footwear that has sufficient traction. • Maintain good housekeeping practices. • Clean up all spills immediately. • Be aware of weather effects on the work area, including wet and/or frozen ground. • Jumping, running, and horseplay are prohibited. • Be cautious when entering or exiting the vessel, and load/unload items onto/off of the pier or shore once boarded. • Keep all areas clean and free of debris to prevent any trips and falls. • Notify the field team members of any unsafe conditions.	• Routinely inspect work area for unsafe conditions.
	Ingestion of contaminants, skin/eye contact with contaminants	• Wear appropriate PPE (uniform/coveralls, work boots, safety glasses, dust mask, and/or gloves) to prevent or reduce exposure. • Contact 911, as necessary; perform CPR if breathing stops. • Move exposed person away from source of contamination, and rinse mouth. • If exposure to skin occurs, promptly wash contaminated skin using soap or mild detergent and water. • Rinse eyes with large amounts of water. • Follow decontamination procedures as outlined in the Health and Safety Plan (HASP).	• Ensure that decontamination procedures are on hand and are reviewed. • Ensure that PPE and rinsing water are available.
	Muscle strain or injuries from improper lifting	• Use proper lifting techniques or ask for assistance with heavy objects. • If boating, avoid carrying objects directly onto or off the boat; rather, load/unload objects while on the boat to/from the pier/shore.	• Evaluate weight and center of gravity of heavier items prior to lifting or moving.
	Pinch points	• If boating, secure any unsecured objects on deck; they may shift on deck quickly in wave, current, or engine acceleration conditions. • Maintain a safe distance from closing mechanisms and moving parts on sampling gear. • Avoid placing hands or self between boat and dock/piles.	

Job Safety Analysis

Sediment Sampling

Work Activity	Potential Hazards	Preventive or Corrective Measures	Inspection Requirements
Sediment sample retrieval and processing (continued)	Wading	• Be aware of potentially slippery surfaces and tripping hazards such as fallen brush, logs, rocks, and other debris. Wear footwear that has sufficient traction. • Be aware of water depth and potential drop-offs. • Be aware of existing and projected river flows. • Wear knee or chest waders as appropriate for traction and to protect against cold water. • Keep extra dry clothes on hand, including socks. • Consider carrying a walking staff for balance. • Always wear a PFD, even if water looks shallow or slow; drop-offs occur and water is often moving faster than it looks. • Avoid entering the water when depths are greater than waist height. • Avoid entering the water in areas of high flow or when large floating debris is present.	• Inspect work area for tripping hazards visible from streambank. • Inspect waders for leaks. • Check depths and flows before wading. • Ensure that change of dry clothes is available if wading in cold weather or cold water conditions.
Working outdoors	Heat stress	• Adjust work schedules, as necessary, to avoid the hottest part of the day. • Take rest breaks as warranted. • Provide shelter (air-conditioned, if possible) or shaded areas to protect personnel during rest periods. • Maintain body fluids at normal levels. • Train workers to recognize the symptoms of heat-related illness.	• Review weather forecast prior to field work. • Monitor workers' physical conditions. • Monitor outside temperature versus worker activity.
	Cold stress	• Provide shelter (enclosed, heated environment) to protect personnel during rest periods. • Educate workers to recognize the symptoms of frostbite and hypothermia. • Use appropriate cold-weather gear, up to and including Mustang-type bib coveralls or jacket/bib combinations. • Consider additional precautions if working near water in cold weather. • Have a dry change of clothing available. • Train workers to recognize the symptoms of cold-related illness.	• Review weather forecast prior to field work. • Monitor workers' physical conditions and PPE. • Monitor outside and water temperature versus worker activity and PPE.
	Rain/snow	• Wear appropriate PPE (rain gear). • Be aware of slip hazards, puddles, and electrical hazards when working in wet conditions. • If extremely cold conditions are forecast, consider additional precautions or postponing work activity.	• Review weather forecast prior to field work. • Inspect PPE daily prior to use. • Routinely inspect work area for deteriorating conditions.

Job Safety Analysis

Sediment Sampling

Work Activity	Potential Hazards	Preventive or Corrective Measures	Inspection Requirements
Working outdoors (continued)	Sunshine	• Have sunscreen available for ultraviolet protection. • Have abundant water available to prevent dehydration. • Consider wearing wide-brimmed headwear and light-colored, lightweight, sun-blocking clothing.	• Ensure that sunscreen and water are available.
	Lightning	• Do not begin or continue work until lightning subsides for 20 minutes. Disconnect and do not use or touch electronic equipment. • Immediately head for shore if on the water and lightning is observed. If not able to get to shore, disconnect and do not use or touch the major electronic equipment, including the radio, throughout the duration of the storm.	• Obtain weather forecast and updates as needed.
	High winds	• Wear goggles or safety glasses if dust or debris are visible.	• Review weather forecast prior to field work. • Ensure that goggles or safety glasses are available.
	Biological hazards (flora [e.g., poison ivy and poison oak] and fauna [e.g., ticks, bees, spiders, and mosquitoes])	• Be aware of likely biological hazards in the work area. • Wear appropriate clothing (i.e., hat, long-sleeve shirt, long pants, leather gloves, boots, and Tyvek coveralls, as appropriate), and apply insect repellant. • Wear hand and arm protection when clearing plants or debris from the work area.	• Ensure that insect repellent is available. • Inspect clothing and skin for insects (e.g., ticks) after working in insect-prone areas.

Training Requirements:

- All personnel working on hazardous waste sites must receive appropriate training as required by 29 CFR 1910.120(e), including but not limited to initial 40-hour, 8-hour supervisor, and annual 8-hour refresher trainings.
- Medical clearance must be received on an annual basis as required by 29 CFR 1910.120(f).
- If boating is involved, and a professional captained vessel is not in use, boat operators must take the appropriate state boater safety courses.
- All assigned employees are required to familiarize themselves with the contents of this JSA before starting a work activity and review it with their supervisor during their daily safety meeting.

Job Safety Analysis

General Boating Activities

Project Name: Pre-Design Data Gaps Sampling	Project Number: 000029-02.56	JSA Number: 003	Issue Date:
Location: Portland Oregon	**Contractor:** Anchor QEA, LLC	**Analysis by:** Christopher R. Torell P.G., CSP	**Analysis Date:** May 2, 2018
Work Operation: General boating activities	**Superintendent/Competent Person:** To Be Determined	**Revised by:**	**Revised Date:**
Required PPE: • USCG-approved PFD; see cold stress section for cold-weather PFD information • See Section 5 of HASP for PPE for activities on vessels other than transportation		**Reviewed by:** Ben Johnson	**Reviewed Date:**
		Approved by: Nik Bacher	**Approved Date:**

Work Activity	Potential Hazards	Preventive or Corrective Measures	Inspection Requirements
Walking on deck	Pinch points	• Secure any unsecured objects on deck; they may shift quickly in wave, current, or engine acceleration conditions. • Maintain a safe distance from closing mechanisms and moving parts, such as on sampling gear. • Avoid placing your hands or yourself between the boat and the dock or piles.	
	Slips, trips, and falls	• Be aware of potentially slippery surfaces, including boat decks, riprap, muddy or algae-covered rocks, shoreline plants or seaweed, thick mud, and tripping hazards. Use handrails where available. • Wear footwear that has sufficient traction. • Maintain good housekeeping practices. • Clean up all spills immediately. • Be aware of weather effects on the work area, including wet and/or frozen ground. • Jumping, running, and horseplay are prohibited. • Be cautious when entering or exiting the vessel, and load/unload items onto/off of the pier or shore once boarded. • Keep all areas clean and free of debris to prevent any trips and falls. • Notify the field team members of any unsafe conditions. • Keep rope lines neatly coiled and stowed. Avoid stepping on or over lines.	• Routinely inspect work area for unsafe conditions.

Job Safety Analysis

General Boating Activities

Work Activity	Potential Hazards	Preventive or Corrective Measures	Inspection Requirements
Walking on deck (continued)	Exceeding boat capacity	• Keep the number of passengers and equipment as posted on boat placards within limits at all times. If conditions warrant, reduce capacity to maintain boat stability.	• Ensure that field team is aware of limits and adheres accordingly.
	Noise exposure	• Wear hearing protection in high noise environments or when working around heavy machinery or equipment (action level of 85 decibels averaged over an 8-hour day).	• Ensure that hearing protection is available.
Working outdoors	Heat stress	• Adjust work schedules, as necessary, to avoid the hottest part of the day. • Take rest breaks as warranted. • Provide shelter (air-conditioned, if possible) or shaded areas to protect personnel during rest periods. • Maintain body fluids at normal levels. • Train workers to recognize the symptoms of heat-related illness.	• Review weather forecast prior to field work. • Monitor workers' physical conditions. • Monitor outside temperature versus worker activity.
	Cold stress	• Provide shelter (enclosed, heated environment) to protect personnel during rest periods. • Educate workers to recognize the symptoms of frostbite and hypothermia. • If the combined air and water temperature is below 90 degrees Fahrenheit (˚F), wear a USCG-approved float coat, Mustang-type bib coveralls, or one-piece survival suit. • Have a dry change of clothing available. • Train workers to recognize the symptoms of cold-related illness.	• Review weather forecast prior to field work. • Monitor workers' physical conditions and PPE. • Monitor outside and water temperature versus worker activity and PPE.
	Rain/snow	• Wear appropriate PPE (rain gear). • Be aware of slip hazards, puddles, and electrical hazards when working in wet conditions. • If extremely cold conditions are forecast, consider additional precautions or postponing work activity.	• Review weather forecast prior to field work. • Inspect PPE daily prior to use. • Routinely inspect work area for deteriorating conditions.
	Sunshine	• Have sunscreen available for ultraviolet protection. • Have abundant water available to prevent dehydration. • Consider wearing wide-brimmed headwear and light-colored, lightweight, sun-blocking clothing.	• Ensure that sunscreen and water are onboard.
	Fog	• Wait for fog to lift for adequate visibility.	• Review weather forecast prior to field work.

Job Safety Analysis

General Boating Activities

Work Activity	Potential Hazards	Preventive or Corrective Measures	Inspection Requirements
Working outdoors (continued)	Lightning	• Do not begin or continue work until lightning subsides for at least 20 minutes. Disconnect and do not use or touch electronic equipment. • Immediately head for shore if on the water and lightning is observed. • If not able to get to shore, disconnect and do not use or touch the major electronic equipment, including the radio, throughout the duration of the storm.	• Obtain weather forecast and updates as needed.
	High river flows or high waves	• Be aware of waves and forecasts and recent rainfall in your watershed.	• Have forecast available.
	High winds	• Wear goggles or safety glasses if dust or debris are visible. • Stow or secure loads or equipment that could be moved by wind, particularly when underway.	• Review weather forecast prior to field work. • Ensure that goggles or safety glasses are onboard.
	Biological hazards (flora [e.g., poison ivy and poison oak] and fauna [e.g., ticks, bees, spiders, and mosquitoes])	• Wear appropriate clothing (i.e., hat, long-sleeve shirt, long pants, leather gloves, boots, and Tyvek coveralls, as appropriate), and apply insect repellent.	• Ensure that insect repellent is onboard.
Vessel emergencies	Person overboard	If you witness someone fall overboard: • Yell, "Person overboard!" • Throw a flotation device immediately. • If the engine is running, take it out of gear and swing the stern clear to keep from hitting the person. • Call 911 or USCG as appropriate. • Assign a spotter to keep the person in sight at all times. • Contact nearby vessels for assistance. • Recover the person from the water. If you fall overboard: • Hold your mouth and nose closed and protect your head. • When you reach the surface, look for movement, listen for sounds, and call for help. Use the whistle attached to the PFD and activate the beacon light. • It is only sensible to swim if there is reason to believe you have a chance of reaching your destination. Too much movement in cold water causes hypothermia.	• Ensure that flotation devices are available. • Ensure that team wears PFDs.

Job Safety Analysis

General Boating Activities

Work Activity	Potential Hazards	Preventive or Corrective Measures	Inspection Requirements
Vessel emergencies (continued)	Fire, abandon ship	• Be prepared to abandon ship in case of major fire (too large to control with a fire extinguisher), or other emergency. • Only the boat captain can order abandon ship. • Communicate intent to abandon ship to all personnel onboard. • Notify USCG and nearby vessels of intent to abandon ship. • Call 911. • Notify the Project Manager and Field Lead, if time permits. • Be aware of the propeller position before abandoning ship. • Identify a rally point for all personnel. • Know the dangers of hypothermia. • Use the buddy system to support injured personnel.	• Ensure that fire extinguisher is available, current, and in working order. • Review abandon ship procedures with field team prior to work.
Navigation	Boat traffic	• Maintain a safe operating distance from shoreline and other vessels.	• Be aware of on-water surroundings.
Motor vehicle operation and trailering	Boat not secured properly	• Ensure that latches, straps, antennas, and onboard gear are secure. Ensure that motor is up and lights are plugged in for driving. • Follow Job Safety Analysis (JSA) for motor vehicle operation.	• Inspect around entire boat before driving.

Training Requirements:

- All personnel working on hazardous waste sites must receive appropriate training as required by 29 CFR 1910.120(e), including but not limited to initial 40-hour, 8-hour supervisor, and annual 8-hour refresher trainings.
- Medical clearance must be received on an annual basis as required by 29 CFR 1910.120(f).
- If professional captained vessel is not in use, boat operators must take appropriate state boater safety courses.
- All assigned employees are required to familiarize themselves with the contents of this JSA before starting a work activity and review it with their supervisor during their daily safety meeting.

Job Safety Analysis

Decontamination Activities

Project Name: Pre-Design Data Gaps Sampling	Project Number: 000029-02.56	JSA Number: 004	Issue Date:
Location: Portland Oregon	**Contractor:** Anchor QEA, LLC	**Analysis by:** Christopher R. Torell P.G., CSP	**Analysis Date:** May 2, 2018
Work Operation: Decontamination activities	**Superintendent/Competent Person:** To Be Determined	**Revised by:**	**Revised Date:**
Required PPE: • Modified Level D—Standard work uniform/coveralls, work boots conforming to ASTM F2412-05, traffic safety vest conforming to ANSI 107, safety glasses conforming to ANSI Z87.1 with permanently installed side shields, hard hat conforming to ANSI Z89, hearing protection • Depending on activity, the following PPE may also be required (see Section 5 of HASP): N95 dust mask, PFD, cold water clothing, disposable chemical coveralls, inner and outer gloves		**Reviewed by:** Ben Johnson **Approved by:** Nik Bacher	**Reviewed Date:** **Approved Date:**

Work Activity	Potential Hazards	Preventive or Corrective Measures	Inspection Requirements
If boating		• Follow the JSA for boating activities.	
Decontamination area set up	Vehicle, heavy equipment traffic, or boat traffic in work area	• Wear high-visibility safety vest and hard hat PPE. • Be alert when working around heavy equipment and/or other boats, especially if wearing hearing protection.	• Ensure that safety vests are available for staff and visitors.
	Muscle strain or injuries from improper lifting	• Use proper lifting techniques or ask for assistance with heavy objects. • If boating, avoid carrying objects directly onto or off of the boat; rather, load/unload objects while on the boat to/from the pier/shore.	• Evaluate weight and center of gravity of heavier items prior to lifting or moving.
	Biological hazards (flora [e.g., poison ivy and poison oak] and fauna [e.g., ticks, bees, spiders, and mosquitoes])	• Be aware of likely biological hazards in the work area. • Wear appropriate clothing (i.e., hat, long-sleeve shirt, long pants, leather gloves, boots, and Tyvek coveralls, as appropriate), and apply insect repellent. • Wear hand and arm protection when clearing plants or debris from the work area.	• Ensure that insect repellent is available. • Inspect clothing and skin for insects (e.g., ticks) after working in insect-prone areas.

Job Safety Analysis

Decontamination Activities

Work Activity	Potential Hazards	Preventive or Corrective Measures	Inspection Requirements
Decontamination activities	Injury from hand and power tool operation (e.g., spatula or drill)	• Be aware of sharp edges on hand tools (e.g., spatulas, knives, drill bits, and saw blades). • Be aware of electrical connections and water hazards when working with electric- or battery-operated tools. • Ensure that all tools are working properly; repair or replace defective tools. Repair when unplugged and off. • Keep guards on power tools when not in use.	• Inspect tools to ensure that they are in good working order. • Inspect electrical connections (if applicable). • Inspect tools periodically to ensure dry and clean operation.
	Noise exposure	• Wear hearing protection in high noise environments or when working around heavy machinery or equipment (action level of 85 decibels averaged over an 8-hour day).	• Ensure that hearing protection is available.
	Slips, trips, and falls	• Be aware of potentially slippery surfaces and tripping hazards. • Use handrails where available. • Wear footwear that has sufficient traction. • Maintain good housekeeping practices. • Clean up all spills immediately. • Be aware of weather effects on the work area, including wet and/or frozen ground. • Jumping, running, and horseplay are prohibited. • Keep all areas clean and free of debris to prevent any trips and falls. • Notify the field team members of any unsafe conditions.	• Routinely inspect work area for unsafe conditions.
	Ingestion of contaminants, skin/eye contact with contaminants	• Wear appropriate PPE to prevent/reduce exposure. • Contact 911, as necessary; perform CPR if breathing stops. • Move exposed person away from source of contamination, and rinse mouth. • If exposure to skin occurs, promptly wash contaminated skin using soap or mild detergent and water. • Rinse eyes with large amounts of water. • Follow decontamination procedures as outlined in the Health and Safety Plan (HASP).	• Ensure that decontamination procedures are on hand and are reviewed. • Ensure that PPE and rinsing water are available.
Working outdoors	Heat stress	• Adjust work schedules, as necessary, to avoid the hottest part of the day. • Take rest breaks as warranted. • Provide shelter (air-conditioned, if possible) or shaded areas to protect personnel during rest periods. • Maintain body fluids at normal levels. • Train workers to recognize the symptoms of heat-related illness.	• Review weather forecast prior to field work. • Monitor workers' physical conditions. • Monitor outside temperature versus worker activity.

Job Safety Analysis

Decontamination Activities

Work Activity	Potential Hazards	Preventive or Corrective Measures	Inspection Requirements
Working outdoors (continued)	Cold stress	• Provide shelter (enclosed, heated environment) to protect personnel during rest periods. • Educate workers to recognize the symptoms of frostbite and hypothermia. • Use appropriate cold-weather gear, up to and including Mustang-type bib coveralls or jacket/bib combinations. • Consider additional precautions if working near water in cold weather. • Have a dry change of clothing available. • Train workers to recognize the symptoms of cold-related illness.	• Review weather forecast prior to field work. • Monitor workers' physical conditions and PPE. • Monitor outside and water temperature versus worker activity and PPE.
	Rain/snow	• Wear appropriate PPE (rain gear). • Be aware of slip hazards, puddles, and electrical hazards when working in wet conditions. • If extremely cold conditions are forecast, consider additional precautions or postponing work activity.	• Review weather forecast prior to field work. • Inspect PPE daily prior to use. • Routinely inspect work area for deteriorating conditions.
	Sunshine	• Have sunscreen available for ultraviolet protection. • Have abundant water available to prevent dehydration. • Consider wearing wide-brimmed headwear and light-colored, lightweight, sun-blocking clothing.	• Ensure that sunscreen and water are available.
	Lightning	• Do not begin or continue work until lightning subsides for at least 20 minutes. Disconnect and do not use or touch electronic equipment.	• Obtain weather forecast and updates as needed.
	High winds	• Wear goggles or safety glasses if dust or debris are visible.	• Review weather forecast prior to field work. • Ensure that goggles or safety glasses are available.

Training Requirements:

- All personnel working on hazardous waste sites must receive appropriate training as required by 29 CFR 1910.120(e), including but not limited to initial 40-hour, 8-hour supervisor, and annual 8-hour refresher trainings.
- Medical clearance must be received on an annual basis as required by 29 CFR 1910.120(f).

Job Safety Analysis

Decontamination Activities

- If boating is involved, and a professional captained vessel is not in use, boat operators must take the appropriate state boater safety courses.
- All assigned employees are required to familiarize themselves with the contents of this JSA before starting a work activity and review it with their supervisor during their daily safety meeting.

Job Safety Analysis

Drilling

Project Name:	Project Number:	JSA Number:	Issue Date:
Pre-Design Data Gaps Sampling	000029-02.56	005	September 13, 2017
Location: Portland, Oregon	**Contractor:** Anchor QEA, LLC	**Analysis by:** Ben Johnson	**Analysis Date:** January 18, 2019
Work Operation: Drilling	**Superintendent/Competent Person:** To Be Determined	**Revised by:**	**Revised Date:**
Required PPE: • Modified Level D—Standard work uniform/coveralls, work boots conforming to ASTM F2412-05, traffic safety vest conforming to ANSI 107, safety glasses conforming to ANSI Z87.1 with permanently installed side shields, hard hat conforming to ANSI Z89, hearing protection • Depending on activity, the following PPE may also be required (see Section 5 of HASP): N95 dust mask, PFD, cold water clothing, disposable chemical coveralls, inner and outer gloves		**Reviewed by:** **Approved by:** Nik Bacher	**Reviewed Date:** **Approved Date:**

Work Activity	Potential Hazards	Preventive or Corrective Measures	Inspection Requirements
If boating		• Follow the JSA for boating activities.	
Borehole logging	Cuts or incisions from opening sample liner with cutting tools	• If possible, have drilling contractor open plastic sample liners. • Wear appropriate PPE. • Cut away from body while opening plastic liners. • Use specialized core cutting table if available.	
	Muscle strain/injuries from improper lifting	• Use proper lifting techniques or ask for assistance with heavy objects.	Evaluate weight and center of gravity of heavier items prior to lifting/moving.

Job Safety Analysis

Drilling

Work Activity	Potential Hazards	Preventive or Corrective Measures	Inspection Requirements
Drilling activities	Rotating and moving equipment	• Set up borehole logging station in area well clear of drill rig and drilling activities. • Set up borehole logging station in an upwind location, if possible. • Stay clear of drill rig while drill rig is in operation.	Get visual contact with driller and ensure driller has shut down rig before approaching drilling work area Confirm with driller that borehole logging station will not be in a potentially hazardous location.
	Traffic	• Use methods such as cones, signs, lights, caution tape, etc., to divert and slow traffic near work site.	Evaluate work site for traffic hazards before commencing work.
	Moving support vehicles or forklifts	• Set up borehole logging station in area well clear of moving vehicles and work zones.	Confirm with driller that borehole logging station will not be in a potentially hazardous location.
	Slips, trips, and falls	• Stay clear of drilling contractor work zones, if possible.	Inspect ground surface for uneven surfaces or equipment before entering a work area.

Training Requirements:

- All personnel working on hazardous waste sites must receive appropriate training as required by 29 Code of Federal Regulations (CFR) 1910.120(e), including, but not limited to initial 40-hour and annual 8-hour refresher training.
- Medical clearance must be received on an annual basis as required by 29 CFR 1910.120 (f).
- All assigned employees are required to familiarize themselves with the contents of this JSA before starting a work activity

Job Safety Analysis

Anchor QEA Motor Vehicle Operation

Project Name: Pre-Design Data Gaps Sampling	**Project Number:** 000029-02.56	**JSA Number:** 006	**Issue Date:**
Location: Portland Oregon	**Contractor:** Anchor QEA, LLC	**Analysis by:** Christopher R. Torell P.G., CSP	**Analysis Date:** May 4, 2018
Work Operation: Anchor QEA motor vehicle operation	**Superintendent/Competent Person:** To Be Determined	**Revised by:**	**Revised Date:**
Required PPE: • Wear seat belt at all times • Make sure that clothing will not interfere with driving		**Reviewed by:** Ben Johnson	**Reviewed Date:**
		Approved by: Nik Bacher	**Approved Date:**

Work Activity	Potential Hazards	Preventive or Corrective Measures	Inspection Requirements
Anchor QEA motor vehicle operation	Unfamiliar with the vehicle	• Allow yourself some time to get familiar with an Anchor QEA vehicle, a rental vehicle, or one not used often. • Test the lights, windshield wipers, hazard lights, horn, parking brake, and other important functions. • Review the dashboard controls, steering radius, and overhead and side clearances. • Allow extra side, front, and back space around the vehicle while driving or parking an unfamiliar vehicle. • Adjust mirrors and the seat while the vehicle is in park. • Drive slowly in confined locations, as in a parking garage, parking lots, or industrial settings. Confirm adequate clearances by sight before turning or backing up in tight or unfamiliar locations. • Use a second person to be a spotter outside the vehicle if needed in tight spaces.	• Inspect fluid levels and air pressure in tires, adjust mirrors and seat positions appropriately, monitor the fuel level, and fill up when the fuel level is low
	Speed and Braking	• Fasten and properly adjust the seat belt. • Obey all posted and designated speed limits. • Radar detectors are prohibited in all company-owned, leased, or rented vehicles. • Reduce travel speed during hazardous conditions (e.g., rain, fog, or snow). • Identify whether your vehicle has Anti-Lock Brakes (ABS). If it does, DO NOT pump the brakes to stop when the vehicle has begun to skid. Apply steady pressure to the brakes. If the vehicle does not have ABS, pump the brakes to stop during slippery conditions.	• Seatbelt • Identify designated speed limits • Determine if vehicle has ABS

Job Safety Analysis

Anchor QEA Motor Vehicle Operation

Work Activity	Potential Hazards	Preventive or Corrective Measures	Inspection Requirements
Anchor QEA motor vehicle operation (continued)	Distance spacing	• Continually check your rear and side view mirrors. • Use the 3-second rule to keep a safe distance between vehicles. • Increase the 3-second rule as necessary during hazardous travel conditions. • Regularly scan the area you will be entering in the next 10 to 12 seconds. • Always leave yourself an "out" during travel. • When stopping, make sure that you leave enough distance between you and the car in front of you. You should be able to see the rear tires of the vehicle in front when stopped. • Obey the speed limit and traffic regulations. • When at a red light and it turns green, use the "delayed start" technique, by counting to three before you take your foot off the brake. • DO NOT TAILGATE. • Keep headlights (and running lights, if available) on for maximum visibility.	• Seatbelt
	Skids	• If the vehicle has begun to skid out of control, turn the steering wheel in the direction of the skid and re-adjust the wheel, as necessary. • Reduce speed during hazardous travel conditions. • Use 4-wheel drive, if available, when driving vehicles off-road, on steep inclines, or in muddy conditions. • Do not take vehicles off-road if they cannot be operated safely in such conditions.	• Seatbelt
	Blind spots	• Become familiar with any blind spots associated with your vehicle. • Adjust mirrors to give the maximum viewing area. • Use your directional devices to signal all turns and when changing lanes; check rear and side view mirror and glance over your shoulder to check that the lane is clear. • Avoid other driver's blind spots; slow down and let the other vehicle pass. • If parked for an extended period and staying in the vehicle, be sure to inspect the area for changed conditions (e.g., a car that moved in behind you) before leaving.	• Seatbelt • Mirrors
	Backing	• Back into parking spaces upon arrival whenever possible. • Perform a 360-degree walk around the vehicle before backing to identify any new conditions or obstructions. • Use a spotter when backing whenever possible. • Understand hand signals. • Sound the horn prior to backing. • Check the rear and side view mirrors prior to backing. • Back slowly in areas of obstructed vision. • Anticipate others who may be backing out into your pathway and adjust accordingly.	• Seatbelt • Mirrors

Anchor QEA Motor Vehicle Operation

Work Activity	Potential Hazards	Preventive or Corrective Measures	Inspection Requirements
Anchor QEA motor vehicle operation (continued)	Distractions (e.g., cell phones, reading maps or directions, eating)	• Do not engage in distracted driving—focus on operating the vehicle, and on your surroundings (e.g., road conditions and other drivers). • Obey state or local laws regarding cell phone use, at a minimum. • Certain clients prohibit cell phone use regardless of the state you are operating in—know your client's policy. • Use hands-free devices (not hand-held cellular phones) while driving. • Pull over to the side of the road when making a call or checking directions.	• Seatbelt • Hands-free devices connected and ready for use
	Accidents	• In the event of an accident, use the following procedures: – Stop, call for medical assistance, notify police, and complete an accident report and submit it to your supervisor. – Notify the Project Manager (PM) and Field Lead (FL). – Complete the appropriate incident investigation reports. – Contact Debbie Ashton, Operations Manager, at (503) 924-6172. – Contact Diana Reynolds, Insurance Liaison, at (302) 236-8403.	• Seatbelt
	Influenced by drugs or alcohol	• NEVER DRIVE UNDER THE INFLUENCE OF DRUGS OR ALCOHOL. • Keep in mind that the person in another vehicle may be under the influence of controlled substances, and be prepared for erratic or sudden driving changes on their part.	• Seatbelt
	Driver attitude	• Do not operate any vehicle when abnormally tired, temporarily disabled (i.e., injured), or under the influence of drugs or alcohol. • Keep an even temper when driving. Do not let the actions of others affect your attitude. • Do not allow yourself to become frustrated, rushed, distracted, or drowsy.	• Seatbelt
	Fatigue	• Stop and rest if fatigued. Exit the road and enter a safe area. Rest until fully refreshed. • Be aware that certain medications (such as cold or allergy medicines) may make you drowsy when driving a vehicle.	• Seatbelt
	Vehicle loading	• DO NOT OVERLOAD the vehicle. • Secure all equipment and supplies within the body of the vehicle using proper tie-downs. • Do not block side view mirrors with the load. • Do not transport U.S. Department of Transportation (DOT)-manifested hazardous materials. • Dispatch all equipment and personnel with proper forms and identification.	• Seatbelt

Job Safety Analysis

Anchor QEA Motor Vehicle Operation

Work Activity	Potential Hazards	Preventive or Corrective Measures	Inspection Requirements
Anchor QEA motor vehicle operation (continued)	Equipment failure	• Perform daily inspections of your vehicle. • Maintain vehicle safety equipment (e.g., mirrors, alarms, horns, wipers, lights, and brakes). • Maintain the vehicle (e.g., tire pressure and fluid levels). • Any vehicle with mechanical defects that may endanger the safety of the driver, passengers, or the public shall not be used. • Ensure that appropriate safety equipment is in the vehicle. Safety equipment should include a spare tire, jack, first-aid kit, fire extinguisher, and flashlight. Flares and/or reflective triangles should be available in larger trucks. • Ensure that the proper documentation is in the vehicle. Documentation should include an operations manual for the vehicle, insurance card, vehicle registration, and accident forms.	• Inspect and maintain the vehicle

Training Requirements:

- All drivers are required to have a valid driver's license, and all vehicles must have appropriate state vehicle registration and inspection stickers. The use of hand-held wireless devices is prohibited while driving any vehicle for business use at any time, for personal use during business hours, and as defined by law.
- **If operating a vehicle or vehicle and trailer with a capacity greater than 10,000 pounds, U.S. Department of Transportation regulations may apply. Contact the PM prior to any travel in this configuration.**
- All assigned employees are required to read, familiarize themselves with the contents of this JSA and review it with their supervisor during their daily safety meeting.

Job Safety Analysis

Active Sheen Blossom Sampling

Project Name: Pre-Design Data Gaps Sampling	**Project Number:** 000029-02.56	**JSA Number:** 007	**Issue Date:**
Location: Portland, Oregon	**Contractor:** Anchor QEA, LLC	**Analysis by:** Ben Johnson	**Analysis Date:** January 18, 2019
Work Operation: Active Sheen Blossom Sampling	**Superintendent/Competent Person:** To Be Determined	**Revised by:**	**Revised Date:**
Required PPE: • Modified Level D—Long pants, long sleeves, and/or Tyvek coveralls if handling potentially contaminated media, and steel-toed footwear conforming to ASTM International (ASTM) F2412-05/ASTM F2413-05 • Safety glasses/splash goggles, hard hat, nitrile outer gloves and latex inner gloves, and, if boating, U.S. Coast Guard-approved personal flotation device (PFD; see cold stress section for cold-weather PFD information)		**Reviewed by:** **Approved by:**	**Reviewed Date:** **Approved Date:**

Work Activity	Potential Hazards	Preventive or Corrective Measures	Inspection Requirements
If boating		• Follow the Job Safety Analysis (JSA) for boating activities.	
If using glassware		• Follow the JSA for handling glassware.	
Sheen net sample retrieval	Slips, trips, and falls	• Avoid walking while writing or texting—maintain a heads-up posture. • Be aware of potentially slippery surfaces, including boat decks, riprap, muddy or algae-covered rocks, shoreline plants or seaweed, thick mud, and tripping hazards. Use handrails where available. Wear footwear that has sufficient traction. • Maintain good housekeeping practices. Clean up all spills immediately. • Be aware of weather effects on the work area, including wet and/or frozen ground. • Jumping, running, and horseplay are prohibited. • Be cautious when entering or exiting the vessel, and load/unload items onto/off of the pier or shore once boarded. • Keep all areas clean and free of debris to prevent any trips and falls. • Notify the field team members of any unsafe conditions.	• Routinely inspect work area for unsafe conditions.

Job Safety Analysis

Active Sheen Blossom Sampling

Work Activity	Potential Hazards	Preventive or Corrective Measures	Inspection Requirements
Sheen net sample retrieval (continued)	Ingestion of contaminants, or skin or eye contact with contaminants	• Wear appropriate PPE (uniform/coveralls, work boots, safety glasses, dust mask, and/or gloves) to prevent or reduce exposure. • Contact 911 if necessary, and perform cardiopulmonary resuscitation (CPR) if breathing stops. • Move the exposed person away from the source of contamination and rinse their mouth. If skin exposure occurs, promptly wash the contaminated skin using soap or mild detergent and water. If eye exposure occurs, rinse the eyes with large amounts of water. • Follow decontamination procedures as outlined in the Health and Safety Plan (HASP).	• Ensure that decontamination procedures are on hand and are reviewed. • Ensure that PPE and rinsing water are available.
	Pinch points	• If boating, secure any unsecured objects on deck; they may shift quickly in wave, current, or engine acceleration conditions. • Maintain a safe distance from closing mechanisms and moving parts on sampling gear. • If boating, avoid placing your hands or yourself between the boat and the dock or piles.	
	Wading	• Be aware of potentially slippery surfaces and tripping hazards such as fallen brush, logs, rocks, and other debris. Wear footwear that has sufficient traction. • Be aware of the water depth and potential drop-offs. • Be aware of existing and projected river flows. • Wear knee or chest waders as appropriate for traction and to protect against cold water. • Keep extra dry clothes on hand, including socks. • Consider carrying a walking staff for balance. • Always wear a PFD, even if water looks shallow or slow; drop-offs occur and water is often moving faster than it looks. • Avoid entering the water when depths are greater than waist height. • Avoid entering the water in areas of high flow or when large floating debris is present.	• Inspect work area for tripping hazards visible from streambank. • Inspect waders for leaks. • Check depths and flows before wading. • Ensure that change of dry clothes is available if wading in cold weather or cold water conditions.
	Biological hazards (flora [e.g., poison ivy and poison oak] and fauna [e.g., ticks, bees, spiders, mosquitoes, and snakes])	• Be aware of likely biological hazards in the work area. • Wear appropriate clothing (i.e., hat, long-sleeve shirt, long pants, leather gloves, boots, and Tyvek coveralls, as appropriate), and apply insect repellent. • Wear hand and arm protection when clearing plants or debris from the work area.	• Ensure that insect repellent is available. • Inspect clothing and skin for insects (e.g., ticks) after working in insect-prone areas.

Job Safety Analysis

Active Sheen Blossom Sampling

Work Activity	Potential Hazards	Preventive or Corrective Measures	Inspection Requirements
	Muscle strain or injuries from improper lifting	• Use proper lifting techniques or ask for assistance with heavy objects, buckets, or other unwieldy equipment. • If boating, avoid carrying objects directly onto or off the boat; rather, load/unload objects while on the boat to/from the pier/shore.	• Evaluate weight and center of gravity of heavier items prior to lifting or moving.
	Noise exposure	• Wear hearing protection in high noise environments or when working around heavy machinery or equipment (action level of 85 decibels averaged over an 8-hour day).	• Ensure that hearing protection is available.
Working outdoors	Heat stress	• Adjust work schedules, as necessary, to avoid the hottest part of the day. • Take rest breaks as warranted. • Provide shelter (air-conditioned, if possible) or shaded areas to protect personnel during rest periods. • Maintain body fluids at normal levels. • Train workers to recognize the symptoms of heat-related illness.	• Review weather forecast prior to field work. • Monitor workers' physical conditions. • Monitor outside temperature versus worker activity.
	Cold stress	• Provide shelter (enclosed, heated environment) to protect personnel during rest periods. • Educate workers to recognize the symptoms of frostbite and hypothermia. • Use appropriate cold-weather gear, up to and including Mustang-type bib coveralls or jacket/bib combinations. • Consider additional precautions if working near water in cold weather. • Have a dry change of clothing available. • Train workers to recognize the symptoms of cold-related illness.	• Review weather forecast prior to field work. • Monitor workers' physical conditions and PPE. • Monitor outside and water temperature versus worker activity and PPE.
	Rain or snow	• Wear appropriate PPE (rain gear). • Be aware of slip hazards, puddles, and electrical hazards when working in wet conditions. • If extremely cold conditions are forecast, consider additional precautions or postponing work activity.	• Review weather forecast prior to field work. • Inspect PPE daily prior to use. • Routinely inspect work area for deteriorating conditions.
	Sunshine	• Have sunscreen available for ultraviolet protection. • Have abundant water available to prevent dehydration. • Consider wearing wide-brimmed headwear and light-colored, lightweight, sun-blocking clothing.	• Ensure that sunscreen and water are available.

Active Sheen Blossom Sampling

Work Activity	Potential Hazards	Preventive or Corrective Measures	Inspection Requirements
	Lightning	• Do not begin or continue work until lightning subsides for at least 30 minutes. Disconnect and do not use or touch electronic equipment. • Immediately head for shore if on the water and lightning is observed. If not able to get to shore, disconnect and do not use or touch the major electronic equipment, including the radio, throughout the duration of the storm.	• Obtain weather forecast and updates as needed.
Working outdoors (continued)	High winds	• Wear goggles or safety glasses if dust or debris are visible.	• Review weather forecast prior to field work. • Ensure that goggles or safety glasses are available.

Training Requirements:

- All personnel working on hazardous waste sites must receive appropriate training as required by 29 Code of Federal Regulations (CFR) 1910.120(e), including but not limited to initial 40-hour, 8-hour supervisor, and annual 8-hour refresher trainings.
- Medical clearance must be received on an annual basis as required by 29 CFR 1910.120(f).
- If boating is involved, and a professional captained vessel is not in use, boat operators must take the appropriate state boater safety courses.
- All assigned employees are required to familiarize themselves with the contents of this JSA before starting a work activity and review it with their supervisor during their daily safety meeting.

Job Safety Analysis

Sample and Laboratory Glassware Handling

Project Name: Pre-Design Data Gaps Sampling	Project Number: 000029-02.56	JSA Number: 009	Issue Date:
Location: Portland Oregon	**Contractor:** Anchor QEA, LLC	**Analysis by:** Christopher R. Torell P.G., CSP	**Analysis Date:** May 2, 2018
Work Operation: Sample and laboratory glassware handling	**Superintendent/Competent Person:**	**Revised by:**	**Revised Date:**
Required PPE: • Modified Level D—Standard work uniform/coveralls, work boots conforming to ASTM F2412-05, traffic safety vest conforming to ANSI 107, safety glasses conforming to ANSI Z87.1 with permanently installed side shields, hard hat conforming to ANSI Z89, hearing protection • Depending on activity, the following PPE may also be required (see Section 5 of HASP): N95 dust mask, PFD, cold water clothing, disposable chemical coveralls, inner and outer gloves		**Reviewed by:** Ben Johnson **Approved by:** Nik Bacher	**Reviewed Date:** **Approved Date:**

Work Activity	Potential Hazards	Preventive or Corrective Measures	Inspection Requirements
Transporting and using glassware	Breakage of containers during field activities	• Use appropriately sized tubs or bottle carriers with dividers to prevent bottle-to-bottle contact during transport. • Consider using coated glassware, if practicable. • Carry oversize bottles in tubs or bottle carriers using both hands during transfer to the sampling vessel and whenever the vessel is underway.	• Ensure dividers are sufficient and will remain in place during transport.
	Faulty glassware	• Replace any glassware that is chipped, nicked, or cracked.	• Inspect glassware before use.
	Impact with equipment and other objects	• Use care when loading and unloading sampling equipment. • Minimize the handling of individual containers to the extent possible.	
Filling sample containers	Over-tightening of bottle lids causing breakage	• Avoid use of excessive force to tighten bottle caps (i.e., finger tight). • Secure lids with clear tape to prevent opening during transport.	
	Breakage during sample collection	• Place containers in plastic tubs between aliquots to limit contact with hard surfaces. • Place containers on a stable and non-slip surface during collection. • Use the buddy system as needed to hold bottles during filling.	

PLAYING IT SAFE

Job Safety Analysis

Sample and Laboratory Glassware Handling

Work Activity	Potential Hazards	Preventive or Corrective Measures	Inspection Requirements
Filling sample containers (continued)	Contact with sample preservatives (generally HCL or H_2SO_4 to lower pH to less than 2)	• Wear nitrile gloves and protective eyewear to prevent skin and eye contact if a container is damaged. • Do not open preserved bottles until necessary.	
Packing samples for shipment	Breakage during packing and shipment	• Use bottle wraps, foam sleeves, or bubble wrap to prevent bottle contact in the cooler. • Pack coolers snugly, but do not over pack.	• Ensure glass bottles do not touch to minimize potential breakage during transport.
Packing samples for shipment	Dry ice use and handling	• Always handle dry ice with thermal gloves, never with bare hands • Avoid contact with unprotected skin at all times (hands, forearms, etc.) • Dry ice must be stored and handled in only well-ventilated areas, to prohibit creation of an oxygen-deficient atmosphere • Do not store dry ice in airtight containers. • Packaging, marking, labeling, loading, and shipping/transporting samples with dry ice may be carried out only by staff who have received specific training required by DOT. Contact Chris Torell in the Syracuse office (315 414 2017) for assistance with ensuring applicable staff are appropriately trained in accordance with DOT regulations. • Shipping samples with dry ice must comply fully with courier requirements.	

Training Requirements:

- All personnel working on hazardous waste sites must receive appropriate training as required by 29 CFR 1910.120(e), including, but not limited to initial 40-hour, 8-hour supervisor, and annual 8-hour refresher trainings.
- Medical clearance must be received on an annual basis as required by 29 CFR 1910.120(f).
- All assigned employees are required to familiarize themselves with the contents of this JSA before starting a work activity and review it with their supervisor during their daily safety meeting.

Job Safety Analysis

Investigation-Derived Waste Management

Project Name: Pre-Design Data Gaps Sampling	**Project Number:** 000029-02.56	**JSA Number:** 010	**Issue Date:**
Location: Portland Oregon	**Contractor:** Anchor QEA, LLC	**Analysis by:** Christopher R. Torell P.G., CSP	**Analysis Date:** May 2, 2018
Work Operation: Investigation-derived waste (IDW) management	**Superintendent/Competent Person:** To Be Determined	**Revised by:**	**Revised Date:**
Required PPE: • Modified Level D—Standard work uniform/coveralls, work boots conforming to ASTM F2412-05, traffic safety vest conforming to ANSI 107, safety glasses conforming to ANSI Z87.1 with permanently installed side shields, hard hat conforming to ANSI Z89, hearing protection • Depending on activity, the following PPE may also be required (see Section 5 of HASP): N95 dust mask, PFD, cold water clothing, disposable chemical coveralls, inner and outer gloves		**Reviewed by:** Ben Johnson **Approved by:** Nik Bacher	**Reviewed Date:** **Approved Date:**

Work Activity	Potential Hazards	Preventive or Corrective Measures	Inspection Requirements
Containerizing IDW at the source	Lifting	• Use care when lifting to redistribute IDW from one container (e.g., drums and buckets) to another at the source. • Seek assistance if loads are too heavy, or if you are experiencing fatigue. • Fill containers only to the degree that will be manageable in the future (e.g., half full) and to limit weight.	• Inspect containers for competency (i.e., no cracks, and handles in good repair).
	Pinch points	• Wear hand protection when closing containers. • Use the buddy system when affixing drum rings.	• Inspect drums for rust or sharp edges prior to opening or closing.
Relocating or staging IDW containers	Lifting	• Use task-specific tools whenever possible to move full containers (i.e., hoists, drum caddies or dollies, and vehicles). • When task-specific tools are not available, use the buddy system to move containers that are reasonable to lift. • Never roll drums or containers holding IDW. • Stage containers in areas protected from heavy traffic and weather, if possible.	• Ensure tools are in good repair. • Assess IDW container weight prior to moving.

Job Safety Analysis

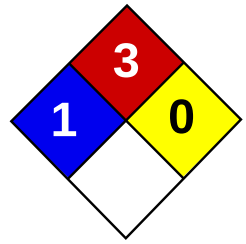
Investigation-Derived Waste Management

Work Activity	Potential Hazards	Preventive or Corrective Measures	Inspection Requirements
Relocating or staging IDW containers (continued)	Pinch points or crushing	• Use tools to achieve the final arrangement when staging containers—do not place hands on the edges of containers while moving them into place. • Stand well clear of containers being moved in case they become dislodged from their handling tool during transport. • Do not stack IDW containers, as this poses a risk for container toppling and damage. • Place containers on a wooden pallet for easy transfer using a pallet jack, if possible.	• Inspect drums for evidence of cracks or rust.
IDW management – general	Splash	• Wear the required PPE at all times. • Use care to minimize splashing or smearing of IDW during handling and containerization.	• Inspect PPE upon donning and periodically during tasks.

Training Requirements:

- All personnel working on hazardous waste sites must receive appropriate training as required by 29 CFR 1910.120(e), including but not limited to initial 40-hour, 8-hour supervisor, and annual 8-hour refresher trainings.
- Medical clearance must be received on an annual basis as required by 29 CFR 1910.120(f).
- All assigned employees are required to familiarize themselves with the contents of this JSA before starting a work activity and review it with their supervisor during their daily safety meeting.

Appendix C
Safety Data Sheets



Health	2
Fire	3
Reactivity	0
Personal Protection	H

Material Safety Data Sheet
Acetone MSDS

Section 1: Chemical Product and Company Identification

Product Name: Acetone

Catalog Codes: SLA3502, SLA1645, SLA3151, SLA3808

CAS#: 67-64-1

RTECS: AL3150000

TSCA: TSCA 8(b) inventory: Acetone

CI#: Not applicable.

Synonym: 2-propanone; Dimethyl Ketone; Dimethylformaldehyde; Pyroacetic Acid

Chemical Name: Acetone

Chemical Formula: C3-H6-O

Contact Information:

Sciencelab.com, Inc.
14025 Smith Rd.
Houston, Texas 77396

US Sales: **1-800-901-7247**
International Sales: **1-281-441-4400**

Order Online: ScienceLab.com

CHEMTREC (24HR Emergency Telephone), call: 1-800-424-9300

International CHEMTREC, call: 1-703-527-3887

For non-emergency assistance, call: 1-281-441-4400

Section 2: Composition and Information on Ingredients

Composition:

Name	CAS #	% by Weight
Acetone	67-64-1	100

Toxicological Data on Ingredients: Acetone: ORAL (LD50): Acute: 5800 mg/kg [Rat]. 3000 mg/kg [Mouse]. 5340 mg/kg [Rabbit]. VAPOR (LC50): Acute: 50100 mg/m 8 hours [Rat]. 44000 mg/m 4 hours [Mouse].

Section 3: Hazards Identification

Potential Acute Health Effects:
Hazardous in case of skin contact (irritant), of eye contact (irritant), of ingestion, of inhalation. Slightly hazardous in case of skin contact (permeator).

Potential Chronic Health Effects:
CARCINOGENIC EFFECTS: A4 (Not classifiable for human or animal.) by ACGIH. MUTAGENIC EFFECTS: Not available. TERATOGENIC EFFECTS: Not available. DEVELOPMENTAL TOXICITY: Classified Reproductive system/toxin/female, Reproductive system/toxin/male [SUSPECTED]. The substance is toxic to central nervous system (CNS). The substance may be toxic to kidneys, the reproductive system, liver, skin. Repeated or prolonged exposure to the substance can produce target organs damage.

Section 4: First Aid Measures

Eye Contact:
Check for and remove any contact lenses. Immediately flush eyes with running water for at least 15 minutes, keeping eyelids open. Cold water may be used. Get medical attention.

Skin Contact:
In case of contact, immediately flush skin with plenty of water. Cover the irritated skin with an emollient. Remove contaminated clothing and shoes. Cold water may be used.Wash clothing before reuse. Thoroughly clean shoes before reuse. Get medical attention.

Serious Skin Contact:
Wash with a disinfectant soap and cover the contaminated skin with an anti-bacterial cream. Seek medical attention.

Inhalation:
If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention if symptoms appear.

Serious Inhalation:
Evacuate the victim to a safe area as soon as possible. Loosen tight clothing such as a collar, tie, belt or waistband. If breathing is difficult, administer oxygen. If the victim is not breathing, perform mouth-to-mouth resuscitation. Seek medical attention.

Ingestion:
Do NOT induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. Loosen tight clothing such as a collar, tie, belt or waistband. Get medical attention if symptoms appear.

Serious Ingestion: Not available.

Section 5: Fire and Explosion Data

Flammability of the Product: Flammable.

Auto-Ignition Temperature: 465°C (869°F)

Flash Points: CLOSED CUP: -20°C (-4°F). OPEN CUP: -9°C (15.8°F) (Cleveland).

Flammable Limits: LOWER: 2.6% UPPER: 12.8%

Products of Combustion: These products are carbon oxides (CO, CO2).

Fire Hazards in Presence of Various Substances: Highly flammable in presence of open flames and sparks, of heat.

Explosion Hazards in Presence of Various Substances:
Risks of explosion of the product in presence of mechanical impact: Not available. Slightly explosive in presence of open flames and sparks, of oxidizing materials, of acids.

Fire Fighting Media and Instructions:
Flammable liquid, soluble or dispersed in water. SMALL FIRE: Use DRY chemical powder. LARGE FIRE: Use alcohol foam, water spray or fog.

Special Remarks on Fire Hazards: Vapor may travel considerable distance to source of ignition and flash back.

Special Remarks on Explosion Hazards:
Forms explosive mixtures with hydrogen peroxide, acetic acid, nitric acid, nitric acid + sulfuric acid, chromic anydride, chromyl chloride, nitrosyl chloride, hexachloromelamine, nitrosyl perchlorate, nitryl perchlorate, permonosulfuric acid, thiodiglycol + hydrogen peroxide, potassium ter-butoxide, sulfur dichloride, 1-methyl-1,3-butadiene, bromoform, carbon, air, chloroform, thitriazylperchlorate.

Section 6: Accidental Release Measures

Small Spill:
Dilute with water and mop up, or absorb with an inert dry material and place in an appropriate waste disposal container.

Large Spill:
Flammable liquid. Keep away from heat. Keep away from sources of ignition. Stop leak if without risk. Absorb with DRY earth, sand or other non-combustible material. Do not touch spilled material. Prevent entry into sewers, basements or confined areas; dike if needed. Be careful that the product is not present at a concentration level above TLV. Check TLV on the MSDS and with local authorities.

Precautions:
Keep locked up.. Keep away from heat. Keep away from sources of ignition. Ground all equipment containing material. Do not ingest. Do not breathe gas/fumes/ vapor/spray. Wear suitable protective clothing. In case of insufficient ventilation, wear suitable respiratory equipment. If ingested, seek medical advice immediately and show the container or the label. Avoid contact with skin and eyes. Keep away from incompatibles such as oxidizing agents, reducing agents, acids, alkalis.

Storage:
Store in a segregated and approved area (flammables area) . Keep container in a cool, well-ventilated area. Keep container tightly closed and sealed until ready for use. Keep away from direct sunlight and heat and avoid all possible sources of ignition (spark or flame).

Engineering Controls:
Provide exhaust ventilation or other engineering controls to keep the airborne concentrations of vapors below their respective threshold limit value. Ensure that eyewash stations and safety showers are proximal to the work-station location.

Personal Protection:
Splash goggles. Lab coat. Vapor respirator. Be sure to use an approved/certified respirator or equivalent. Gloves.

Personal Protection in Case of a Large Spill:
Splash goggles. Full suit. Vapor respirator. Boots. Gloves. A self contained breathing apparatus should be used to avoid inhalation of the product. Suggested protective clothing might not be sufficient; consult a specialist BEFORE handling this product.

Exposure Limits:
TWA: 500 STEL: 750 (ppm) from ACGIH (TLV) [United States] TWA: 750 STEL: 1000 (ppm) from OSHA (PEL) [United States] TWA: 500 STEL: 1000 [Austalia] TWA: 1185 STEL: 2375 (mg/m3) [Australia] TWA: 750 STEL: 1500 (ppm) [United Kingdom (UK)] TWA: 1810 STEL: 3620 (mg/m3) [United Kingdom (UK)] TWA: 1800 STEL: 2400 from OSHA (PEL) [United States]Consult local authorities for acceptable exposure limits.

Section 9: Physical and Chemical Properties

Physical state and appearance: Liquid.

Odor: Fruity. Mint-like. Fragrant. Ethereal

Taste: Pungent, Sweetish

Molecular Weight: 58.08 g/mole

Color: Colorless. Clear

pH (1% soln/water): Not available.

Boiling Point: 56.2°C (133.2°F)

Melting Point: -95.35 (-139.6°F)

Critical Temperature: 235°C (455°F)

Specific Gravity: 0.79 (Water = 1)

Vapor Pressure: 24 kPa (@ 20°C)

Vapor Density: 2 (Air = 1)

Volatility: Not available.

Odor Threshold: 62 ppm

Water/Oil Dist. Coeff.: The product is more soluble in water; log(oil/water) = -0.2

Ionicity (in Water): Not available.

Dispersion Properties: See solubility in water.

Solubility: Easily soluble in cold water, hot water.

Stability: The product is stable.

Instability Temperature: Not available.

Conditions of Instability: Excess heat, ignition sources, exposure to moisture, air, or water, incompatible materials.

Incompatibility with various substances: Reactive with oxidizing agents, reducing agents, acids, alkalis.

Corrosivity: Non-corrosive in presence of glass.

Special Remarks on Reactivity: Not available.

Special Remarks on Corrosivity: Not available.

Polymerization: Will not occur.

Section 11: Toxicological Information

Routes of Entry: Absorbed through skin. Dermal contact. Eye contact. Inhalation.

Toxicity to Animals:
WARNING: THE LC50 VALUES HEREUNDER ARE ESTIMATED ON THE BASIS OF A 4-HOUR EXPOSURE. Acute oral toxicity (LD50): 3000 mg/kg [Mouse]. Acute toxicity of the vapor (LC50): 44000 mg/m3 4 hours [Mouse].

Chronic Effects on Humans:
CARCINOGENIC EFFECTS: A4 (Not classifiable for human or animal.) by ACGIH. DEVELOPMENTAL TOXICITY: Classified Reproductive system/toxin/female, Reproductive system/toxin/male [SUSPECTED]. Causes damage to the following organs: central nervous system (CNS). May cause damage to the following organs: kidneys, the reproductive system, liver, skin.

Other Toxic Effects on Humans:
Hazardous in case of skin contact (irritant), of ingestion, of inhalation. Slightly hazardous in case of skin contact (permeator).

Special Remarks on Toxicity to Animals: Not available.

Special Remarks on Chronic Effects on Humans:
May affect genetic material (mutagenicity) based on studies with yeast (S. cerevisiae), bacteria, and hamster fibroblast cells. May cause reproductive effects (fertility) based upon animal studies. May contain trace amounts of benzene and formaldehyde which may cancer and birth defects. Human: passes the placental barrier.

Special Remarks on other Toxic Effects on Humans:
Acute Potential Health Effects: Skin: May cause skin irritation. May be harmful if absorbed through the skin. Eyes: Causes eye irritation, characterized by a burning sensation, redness, tearing, inflammation, and possible corneal injury. Inhalation: Inhalation at high concentrations affects the sense organs, brain and causes respiratory tract irritation. It also may affect the Central Nervous System (behavior) characterized by dizzness, drowsiness, confusion, headache, muscle weakeness, and possibly motor incoordination, speech abnormalities, narcotic effects and coma. Inhalation may also affect the gastrointestinal tract (nausea, vomiting). Ingestion: May cause irritation of the digestive (gastrointestinal) tract (nausea, vomiting). It may also

affect the Central Nevous System (behavior), characterized by depression, fatigue, excitement, stupor, coma, headache, altered sleep time, ataxia, tremors as well at the blood, liver, and urinary system (kidney, bladder, ureter) and endocrine system. May also have musculoskeletal effects. Chronic Potential Health Effects: Skin: May cause dermatitis. Eyes: Eye irritation.

Ecotoxicity:
Ecotoxicity in water (LC50): 5540 mg/l 96 hours [Trout]. 8300 mg/l 96 hours [Bluegill]. 7500 mg/l 96 hours [Fatthead Minnow]. 0.1 ppm any hours [Water flea].

BOD5 and COD: Not available.

Products of Biodegradation:
Possibly hazardous short term degradation products are not likely. However, long term degradation products may arise.

Toxicity of the Products of Biodegradation: The product itself and its products of degradation are not toxic.

Special Remarks on the Products of Biodegradation: Not available.

Waste Disposal:
Waste must be disposed of in accordance with federal, state and local environmental control regulations.

Section 14: Transport Information

DOT Classification: CLASS 3: Flammable liquid.

Identification: : Acetone UNNA: 1090 PG: II

Special Provisions for Transport: Not available.

Section 15: Other Regulatory Information

Federal and State Regulations:
California prop. 65: This product contains the following ingredients for which the State of California has found to cause reproductive harm (male) which would require a warning under the statute: Benzene California prop. 65: This product contains the following ingredients for which the State of California has found to cause birth defects which would require a warning under the statute: Benzene California prop. 65: This product contains the following ingredients for which the State of California has found to cause cancer which would require a warning under the statute: Benzene, Formaldehyde Connecticut hazardous material survey.: Acetone Illinois toxic substances disclosure to employee act: Acetone Illinois chemical safety act: Acetone New York release reporting list: Acetone Rhode Island RTK hazardous substances: Acetone Pennsylvania RTK: Acetone Florida: Acetone Minnesota: Acetone Massachusetts RTK: Acetone Massachusetts spill list: Acetone New Jersey: Acetone New Jersey spill list: Acetone Louisiana spill reporting: Acetone California List of Hazardous Substances (8 CCR 339): Acetone TSCA 8(b) inventory: Acetone TSCA 4(a) final test rules: Acetone TSCA 8(a) IUR: Acetone

Other Regulations:
OSHA: Hazardous by definition of Hazard Communication Standard (29 CFR 1910.1200). EINECS: This product is on the European Inventory of Existing Commercial Chemical Substances.

Other Classifications:

WHMIS (Canada):
CLASS B-2: Flammable liquid with a flash point lower than 37.8°C (100°F). CLASS D-2B: Material causing other toxic effects (TOXIC).

DSCL (EEC):
R11- Highly flammable. R36- Irritating to eyes. S9- Keep container in a well-ventilated place. S16- Keep away from sources of ignition - No smoking. S26- In case of contact with eyes, rinse immediately with plenty of water and seek medical advice.

HMIS (U.S.A.):

Health Hazard: 2

Fire Hazard: 3

Reactivity: 0

Personal Protection: h

National Fire Protection Association (U.S.A.):

Health: 1

Flammability: 3

Reactivity: 0

Specific hazard:

Protective Equipment:
Gloves. Lab coat. Vapor respirator. Be sure to use an approved/certified respirator or equivalent. Wear appropriate respirator when ventilation is inadequate. Splash goggles.

Section 16: Other Information

References:
-Material safety data sheet issued by: la Commission de la SantÃ© et de la SÃ©curitÃ© du Travail du QuÃ©bec. -The Sigma-Aldrich Library of Chemical Safety Data, Edition II. -Hawley, G.G.. The Condensed Chemical Dictionary, 11e ed., New York N.Y., Van Nostrand Reinold, 1987. LOLI, RTECS, HSDB databases. Other MSDSs

Other Special Considerations: Not available.

Created: 10/10/2005 08:13 PM

Last Updated: 05/21/2013 12:00 PM

Aquabiotics Industrial Pty. Ltd
SAFETY DATA SHEET

1. IDENTIFICATION OF THE MATERIAL AND SUPPLIER

Product Name: BoreSaver Ultra C

Other names: Oxalic acid (stabilized), Ethanedioic acid; Dicarboxylic acid.
Supplier: **Aquabiotics Industrial Pty Ltd**
ABN: 90119750186
Address: 14 Goongarrie Street, Bayswater, Western Australia 6053
Tel: (All Hours)+61 (0)8 9379 2911 Fax: +61 (0)8 676856.
E-mail: sales@boresaver.com.au

Additional European Addresses:
Italy: Millars Products s.r.l.
Segrate (Milano), Italy
Tel: 0039 02 2134267 Fax: 0039 02 2132456

LAVAL UNDERGROUND SURVEYS. LLC
2476 N. BUNDY AVE
FRESNO CALIFORNIA 937727 U.S.A.
TELEPHONE: (559)251-1396

United Kingdom: geoquip project services limited
Unit 7 Sovereign Centre, Farthing Road Industrial Estate
Ipswich, Suffolk, England, IP1 5AP
Tel: 0044 (0)1473 463546 Fax: 0044 (0)1473 462146

2. HAZARDS IDENTIFICATION

Not classified as Dangerous Goods by the criteria of the Australian Dangerous Goods Code (ADG Code) for transport by Road and Rail; **NON-DANGEROUS GOODS**.

This material is hazardous according to Safe Work Australia; HAZARDOUS SUBSTANCE.

Classification of the substance or mixture:

Acute Oral Toxicity -	Category 4
Acute Dermal Toxicity -	Category 4
Eye Damage -	Category 1

SIGNAL WORD: DANGER

Hazard Statement(s):
H302+H312 Harmful if swallowed or in contact with skin.
H318 Causes serious eye damage.
Precautionary Statement(s):
Prevention:
P264 Wash hands thoroughly after handling.
P270 Do not eat, drink or smoke when using this product.
P280 Wear protective gloves / protective clothing / eye protection / face protection.

Response:
P301+P312 IF SWALLOWED: Call a POISON CENTER or doctor/physician if you feel unwell.
P330 Rinse mouth.
P302+P352 IF ON SKIN: Wash with plenty of soap and water.
P312 Call a POISON CENTER or doctor/physician if you feel unwell.
P363 Wash contaminated clothing before re-use.
P322 Specific measures (see First Aid Measures on Safety Data Sheet).
P305+P351+P338 IF IN EYES: Rinse cautiously with water for several minutes.
Remove contact lenses, if present and easy to do. Continue rinsing.
P310 immediately call a POISON CENTER or doctor/physician.

Disposal:
P501 Dispose of contents/container in accordance with local/regional/national/international regulations.

3. COMPOSITION/INFORMATION ON INGREDIENTS

Components	CAS Number	Proportion	Hazard Codes
Oxalic acid (processed)	144-62-7	>90%	H312 H302
Stabilizers N.O.S.	**NA**	**To 100%**	**NA**

4. FIRST AID MEASURES

Inhalation:
Remove victim from area of exposure - avoid becoming a casualty. Remove contaminated clothing and loosen remaining clothing. Allow patient to assume most comfortable position and keep warm. Keep at rest until fully recovered. Seek medical advice if effects persist.
Skin Contact:
If skin or hair contact occurs, immediately remove any contaminated clothing and wash skin and hair thoroughly with running water. If swelling, redness, blistering or irritation occurs seek medical assistance.
Eye Contact:
Immediately wash in and around the eye area with large amounts of water for at least 15 minutes. Eyelids to be held apart. Remove clothing if contaminated and wash skin. Urgently seek medical assistance. Transport to hospital or medical centre.
Ingestion:
Rinse mouth with water. If swallowed, do NOT induce vomiting. Give a glass of water. Seek immediate medical assistance.
Indication of immediate medical attention and special treatment needed:
Treat symptomatically. Can cause corneal burns.

5. FIRE FIGHTING MEASURES

Flammable Properties: During a fire, corrosive and toxic gases may be generated by thermal decomposition.
Hazardous Combustion Products: This material will not burn.
Fire / Explosion Hazards: May react violently with: strong bases strong oxidizers
Static Discharge: None reported.
Mechanical Impact: None reported
Extinguishing Media: Use media appropriate to surrounding fire conditions
Extinguishing Media NOT To Be Used: Not applicable
Fire Fighting Instruction: As in any fire, wear self-contained breathing apparatus pressure-demand and full protective gear. Containers can build up pressure if exposed to high levels of heat.

6. ACCIDENTAL RELEASE MEASURES

Emergency procedures/Environmental precautions:
Clear area of all unprotected personnel. If contamination of sewers or waterways has occurred advise local emergency services.

Personal precautions/Protective equipment/Methods and materials for containment and cleaning up:
Avoid accidents, clean up immediately. Wear protective equipment to prevent skin and eye contact and breathing in dust. Sweep up, but avoid generating dust. Collect and seal in properly labeled containers or drums for disposal.

7. HANDLING AND STORAGE

This material is a Scheduled Poison S6 and must be stored, maintained and used in accordance with the relevant regulations.

Precautions for safe handling:
Avoid skin and eye contact and breathing in dust. Avoid handling which leads to dust formation.

Conditions for safe storage, including any incompatibilities:
Store in a cool, dry, well-ventilated place and out of direct sunlight. Store away from foodstuffs. Store away from incompatible materials described in Section 10. Keep containers closed when not in use - check regularly for spills.

Use of the substance/preparation: A cleaning agent to remove iron oxide from water bores, pumps, reticulation systems and other industrial water systems.

8. EXPOSURE CONTROLS / PROTECTIVE EQUIPMENT

Oxalic acid: 8hr TWA = 1 mg/m3, 15 min STEL = 2 mg/m3

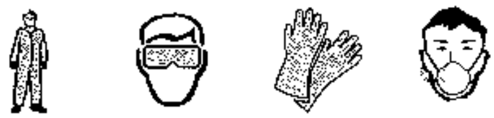
As published by Safe Work Australia Workplace Exposure Standards for Airborne Contaminants.
TWA - The time-weighted average airborne concentration of a particular substance when calculated over an eight-hour working day, for a five-day working week.

STEL (Short Term Exposure Limit) - the airborne concentration of a particular substance calculated as a time-weighted average over 15 minutes, which should not be exceeded at any time during a normal eight hour work day. According to current knowledge this concentration should neither impair the health of, nor cause undue discomfort to, nearly all workers.

These Workplace Exposure Standards are guides to be used in the control of occupational health hazards. All atmospheric contamination should be kept to as low a level as is workable. These workplace exposure standards should not be used as fine dividing lines between safe and dangerous concentrations of chemicals. They are not a measure of relative toxicity.

Appropriate engineering controls:
Ensure ventilation is adequate to maintain air concentrations below Workplace Exposure Standards. If inhalation risk exists: Use with local exhaust ventilation or while wearing dust mask. Keep containers closed when not in use.

Individual protection measures, such as Personal Protective Equipment (PPE):
The selection of PPE is dependent on a detailed risk assessment. The risk assessment should consider the work situation, the physical form of the chemical, the handling methods, and environmental factors.
Orica Personal Protection Guide No. 1, 1998: F - OVERALLS, SAFETY SHOES, CHEMICAL GOGGLES, GLOVES, DUST MASK.



Wear overalls, chemical goggles and impervious gloves. Avoid generating and inhaling dusts. If dust exists, wear dust mask/respirator meeting the requirements of AS/NZS 1715 and AS/NZS 1716. Always wash hands before smoking, eating, drinking or using the toilet. Wash contaminated clothing and other protective equipment before storage or re-use. **NOTE: BoreSaver Ultra C is manufactured to present no dust hazard to users.**

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9. PHYSICAL / CHEMICAL PROPERTIES

Appearance: white unconsolidated crystalline solid mixture. Non-flammable, non-volatile.
Physical state: Granules or Crystals
Colour: White to Clear
Odour: Odourless
Solubility: Soluble in water , glycerol and alcohol. Partially soluble in ether. Insoluble in chloroform, petroleum ether and benzene .
Specific Gravity: 1.65 @20°C
Relative Vapour Density (air=1): Not available
Vapour Pressure (20 °C): <0.14 Pa
Flash Point (°C): Not applicable
Flammability Limits (%): Not available
Autoignition Temperature (°C): Not available
Melting Point/Range (°C): 101.5
Decomposition Point (°C): Not available
pH: 1.3 (0.1M when in solution) ***Supplied product is NOT in solution.***
Metal Corrosivity:
Steel: Not determined
Aluminum: Not determined

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10. STABILITY / REACTIVITY

Chemical Stability: Stable when stored under proper conditions.
Conditions to Avoid: Heat
Reactivity / Incompatibility: Incompatible with: oxidizers alkalies. Dry oxalic acid is not corrosive to metals.
Hazardous Decomposition: Heating to decomposition releases toxic fumes of carbon monoxide and carbon dioxide.
Hazardous Polymerization: Will not occur.

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11. TOXICOLOGICAL INFORMATION

No adverse health effects expected if the product is handled in accordance with this Safety Data Sheet and the product label.

Symptoms or effects that may arise if the product is mishandled and overexposure occurs are:

Ingestion: Swallowing can result in a severe burning pain of the mouth, throat and stomach followed by profuse vomiting (sometimes bloody). Small doses of oxalate in the body can cause headache, pain and twitching in muscles, and cramps. Larger doses can cause weak and irregular heartbeat, drop in blood pressure and signs of heart failure. Large doses rapidly cause a shock-like state, convulsions, coma and possibly death.

Eye contact: A severe eye irritant. Contamination of eyes can result in permanent injury.

Skin contact: Contact with skin may result in irritation. Solutions of 5% to 10% oxalic acid are irritating to the skin after prolonged exposure and can cause corrosive injury.

Inhalation: Breathing in dust may result in respiratory irritation. Inhaled oxalic acid is readily absorbed into the body and may cause headaches and nausea. Boresaver Ultra C is manufactured such that there is no dust hazard.

Acute toxicity:
Oral LD50 (rat): 475 mg/kg
Dermal LD50 (rabbit): 2000 mg/kg

Chronic effects: Long term exposure can result in kidney stones and stone formation in the urinary tract.

Exposure to this compound can result in systemic effects including kidney damage, muscle twitching, cramps and nervous system complaints.

This product does NOT contain any IARC listed chemicals.

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12. ECOLOGICAL INFORMATION

Ecotoxicity: Avoid contaminating waterways in raw or concentrated state.

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13. DISPOSAL CONSIDERATIONS

Disposal methods:
Refer to Waste Management Authority. Dispose of contents/container in accordance with local/regional/national/international regulations.

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14. TRANSPORT INFORMATION

Road and Rail Transport
Not classified as Dangerous Goods by the criteria of the Australian Dangerous Goods Code (ADG Code) for transport by Road and Rail; NON-DANGEROUS GOODS.

Marine Transport
Not classified as Dangerous Goods by the criteria of the International Maritime Dangerous Goods Code (IMDG Code) for transport by sea; NON-DANGEROUS GOODS.

Air Transport
Not classified as Dangerous Goods by the criteria of the International Air Transport Association (IATA) Dangerous Goods Regulations for transport by air; NON-DANGEROUS GOODS.

UN number: NA

UN proper shipping name: OXALIC ACID DIHYDRATE (STABALISED)

15. REGULATORY INFORMATION

Classification:
This material is hazardous according to Safe Work Australia; HAZARDOUS SUBSTANCE.

Classification of the substance or mixture:
Acute Oral Toxicity - Category 4
Acute Dermal Toxicity - Category 4
Eye Damage - Category 1

Hazard Statement(s):
H302+H312 Harmful if swallowed or in contact with skin.
H318 Causes serious eye damage.

Poisons Schedule (SUSMP): S6 Poison.

This material is listed on the Australian Inventory of Chemical Substances (AICS).
National Inventories:
REACH Registration Number: A registration number is not available for this substance as the substance or its use is exempted from registration according to Article 2 REACH regulation (EC) No 1907/2006, the annual tonnage doesn't not require registration or the registration is envisaged for a later registration deadline.

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16. OTHER INFORMATION

References: 29 CFR 1900 - 1910 (Code of Federal Regulations - Labor). Air Contaminants, Federal Register, Vol. 54, No. 12. Thursday, January 19, 1989. pp. 2332-2983. TLV's Threshold Limit Values and Biological Exposure Indices for 1992-1993. American Conference of Governmental Industrial Hygienists, 1992. CCINFO RTECS. Canadian Centre for Occupational Health and Safety. Hamilton, Ontario Canada: 30 June 1993. Sax, N. Irving. Dangerous Properties of Industrial Materials, 7th Ed. New York: Van Nostrand Reinhold Co., 1989. Vendor Information. The Merck Index, 11th Ed. Rahway, New Jersey: Merck and Co., Inc., 1989. Fire Protection Guide on Hazardous Materials, 10th Ed. Quincy, MA: National Fire Protection Fire Protection Guide on Hazardous Materials, 10th Ed. Quincy, MA: National Fire Protection Association, 1991. Technical Judgment.

Use of the substance/preparation: A cleaning agent to remove iron oxide from water bores, pumps, reticulation systems and other industrial water systems.

Supplier Safety Data Sheet; 03/ 2013.
This safety data sheet is based on one prepared by Orica Toxicology & SDS Services. Only section:1 contact information has been modified.

This SDS summarises to our best knowledge at the date of issue, the chemical health and safety hazards of the material and general guidance on how to safely handle the material in the workplace. Since Orica Limited cannot anticipate or control the conditions under which the product may be used, each user must, prior to usage, assess and control the risks arising from its use of the material.

Legend:
NA - Not Applicable w/w - weight/weight
ND - Not Determined w/v - weight/volume
NV - Not Available v/v - volume/volume
USER RESPONSIBILITY: Each user should read and understand this information and incorporate it in individual site safety programs in accordance with applicable hazard communication standards and regulations.
THE INFORMATION CONTAINED HEREIN IS BASED ON DATA CONSIDERED TO BE ACCURATE.
HOWEVER, NO WARRANTY IS EXPRESSED OR IMPLIED REGARDING THE ACCURACY OF THESE DATA OR THE RESULTS TO BE OBTAINED FROM THE USE THEREOF.

OAKTON®

MATERIAL SAFETY DATA SHEET

Section 1. Chemical Product and Company Identification

Catalog Number(s)

00606-10, 00653-15, 00653-16, 00653-18, 00653-20, 00653-23, 00653-27, 00653-32, 00653-47, 00653-50, 00653-89, 35653-09, 35653-10, 35653-11, 35653-12, 35653-13, 35656-18, 35656-47

Product Identity

CONDUCTIVITY STANDARD SOLUTIONS, < 90 mS

Manufacturer's Name	Emergency Telephone Number (24 hr)
RICCA CHEMICAL COMPANY	CHEMTREC®: 800-424-9300
Address (Number, Street, City, State, and ZIP Code)	Telephone Number For Information
P.O. Box 13090	817-461-5601
	Date Prepared
Arlington, Texas 76094	3-17-2000

Section 2. Composition / Information on Ingredients

		Percent	Exposure Limits	
Component	CAS Registry #	Concentration	ACGIH TLV	OSHA PEL
Potassium Chloride	7447-40-7	< 6	N/A	N/A
Water, Deionized	7732-18-5	Balance	N/A	N/A

Section 3. Hazards Identification

☆☆

EMERGENCY OVERVIEW

Clear, colorless liquid. Non-flammable, non-toxic, non-corrosive. Does not present any significant health hazards.

☆☆

POTENTIAL HEALTH EFFECTS:

TARGET ORGANS: eyes, skin.

EYE CONTACT: May cause irritation.

INHALATION: Not likely to be hazardous by inhalation.

SKIN CONTACT: May cause slight irritation.

INGESTION: Large doses may cause stomach upset.

CHRONIC EFFECTS / CARCINOGENICITY:

IARC – No
NTP – No
OSHA – No

TERATOLOGY (BIRTH DEFECT) INFORMATION:

Mutation data cited in 'Registry of Toxic Effects of Chemical Substances' for Potassium Chloride.

REPRODUCTION INFORMATION:

No information found in "Registry of Toxic Effects of Chemical Substances" or other information sources.

Section 4. First Aid Measures – In all cases, seek qualified evaluation.

EYE CONTACT: Irrigate immediately with large quantity of water for at least 15 minutes.

INHALATION: Remove to fresh air. Give artificial respiration if necessary.

SKIN CONTACT: Flush with plenty of water for at least 15 minutes.

INGESTION: Dilute with water or milk. Call a physician if necessary.

Section 5. Fire Fighting Measures

FLAMMABLE PROPERTIES:

FLASH POINT: N/A METHOD USED: N/A

FLAMMABLE LIMITS

LFL: N/A UFL: N/A

EXTINGUISHING MEDIA: Use any means suitable for extinguishing surrounding fire.

FIRE & EXPLOSION HAZARDS: Not considered to be a fire or explosion hazard.

FIRE FIGHTING INSTRUCTIONS: Use normal procedures/instructions.

FIRE FIGHTING EQUIPMENT: Use protective clothing and breathing equipment appropriate for the surrounding fire.

Section 6. Accidental Release Measures

Absorb with suitable material (paper towels, etc.) and dispose of in accordance with local regulations. Small amounts may be flushed to the sewer with plenty of water.

Section 7. Handling and Storage

As with all chemicals, wash hands thoroughly after handling. Avoid contact with eyes and skin. Protect from freezing and physical damage. SAFETY STORAGE CODE: GENERAL

Section 8. Exposure Controls / Personal Protection

ENGINEERING CONTROLS: No specific controls are needed. Normal room ventilation is adequate.

RESPIRATORY PROTECTION: Normal room ventilation is adequate.

SKIN PROTECTION: Chemical resistant gloves are recommended.

EYE PROTECTION: Safety glasses or goggles.

Section 9. Physical and chemical Properties

APPEARANCE:	Clear, colorless liquid	**pH:**	approximately 7
ODOR:	Odorless	**BOILING POINT (^{o}C):**	approximately 100
SOLUBILITY IN WATER:	Infinite	**MELTING POINT (^{o}C):**	approximately 0
SPECIFIC GRAVITY:	approximately 1.0 – 1.04	**VAPOR PRESSURE:**	N/A

Section 10. Stability and Reactivity

CHEMICAL STABILITY: Stable under normal conditions of use and storage.

INCOMPATIBILITY: Bromine Trifluoride, Potassium Permanganate plus Sulfuric Acid.

HAZARDOUS DECOMPOSITION PRODUCTS: Oxides of Potassium.

HAZARDOUS POLYMERIZATION: Will not occur.

Section 11. Toxicological Information

LD_{50}, Oral, Rat: 2600 mg/kg (Potassium Chloride), details of toxic effects not reported other than lethal dose value. Irritation: eye, rabbit (500mg/24 hr mild).

Section 12. Ecological Information

ECOTOXICOLOGICAL INFORMATION: No information found.

CHEMICAL FATE INFORMATION: No information found.

Section 13. Disposal Considerations

Dilute with water and flush to sewer if local regulations allow. If not allowed, save for recovery or recycling in an approved waste disposal facility. Always dispose of in accordance with local, state and federal regulations.

Section 14. Transport Information (Not meant to be all inclusive)

D.O.T. SHIPPING NAME:	Not regulated
D.O.T. HAZARD CLASS:	None
U.N. / N.A. NUMBER:	None
PACKING GROUP:	None
D.O.T. LABEL:	None

Section 15. Regulatory Information (Not meant to be all inclusive - selected regulation represented)

OSHA STATUS: The above items either do not contain any specifically hazardous material or the potentially hazardous material is present in such low concentration that the items do not present any immediate threat to health and safety. These items do not meet the OSHA Hazard Communication Standard (29 CFR 1910.1200) definition of a hazardous material.

TSCA STATUS: All components of this solution are listed on the TSCA Inventory.
CERCLA REPORTABLE QUANTITY: Not reportable
SARA TITLE III:

SECTION 302 EXTREMELY HAZARDOUS SUBSTANCES: No
SECTION 311/312 HAZARDOUS CATEGORIES: No
SECTION 313 TOXIC CHEMICALS: No
RCRA STATUS: No

CALIFORNIA PROPOSITION 65: Not listed

Section 16. Other Information

NFPA® Ratings:	**Health: 0**	**Flammability: 0**	**Reactivity: 0**	**Special Notice Key: None**
HMIS® Ratings:	**Health: 0**	**Flammability: 0**	**Reactivity: 0**	**Protective Equipment: B (Protective eyewear, gloves)**

Rev 1, 10-16-2000: (Section 1) added catalog numbers 35653-10, 35653-11, 35653-12, and 35653-13.
Rev 2, 12-06-2001: (Section 1) added catalog number 35653-09; revised description from 23µ - 80 mS.
Rev 3, 03-25-2003: Reviewed and approved, (Section 3) added mutation statement, (Section 11) added irritation data.
Rev 4, 03-20-2006: Reviewed and approved.

When handled properly by qualified personnel, the product described herein does not present a significant health or safety hazard. Alteration of its characteristics by concentration, evaporation, addition of other substances, or other means may present hazards not specifically addressed herein and which must be evaluated by the user. The information furnished herein is believed to be accurate and represents the best data currently available to us. No warranty, expressed or implied, is made and RICCA CHEMICAL COMPANY assumes no legal responsibility or liability whatsoever resulting from its use.

MSDS	Material Safety Data Sheet for #2 Diesel

Definition of terms

1. Chemical Product

MSDS Number: U7770

MSDS Date: 01-31-99

Product Name: #2 Diesel Fuel

24 Hour Emergency Phone: (210) 979-8346
Transportation Emergencies: Call Chemtrec at 1-800-424-9300
MSDS Assistance: (210) 592-4593

Distributors Name and Address:
T.W. Brown Oil Co., Inc.
1857 Knoll Drive
Ventura, California 93003

Chemical Name:#2 Diesel Fuel **Cas Number:** 68476-34-6

Synonyms/Common Names: This Material Safety Data Sheet applies to the following product descriptions for Hazard Communication purposes only. Technical specifications vary greatly depending on the product, and are not reflected in this document. Consult specification sheets for technical information.

California Air Resources Board (Carb) Diesel Fuel- On-road, Off-Road, Tax Exempt blends
Premium Diesel Fuel- Low-Sulfur, High-sulfur, On-Road, Off-Road, Tax Exempt blends
#2 Distillate- Low-Sulfur, High-sulfur, On-Road, Off-Road, Tax Exempt blends
#2 Diesel Fuel- Low-Sulfur, High-sulfur, On-Road, Off-Road, Tax Exempt blends
#2 Fuel Oil- Low-Sulfur, High-sulfur, On-Road, Off-Road, Tax Exempt blends

2. Composition, Information On Ingredients

Product Use: This product is intended for use as a fuel in engines and heaters designed for diesel fuels, and for use in engineered processes. Use in other applicatiions may result in higher exposures and require additional controls, such as local exhaust ventilation and personal protective equipment.

Description: #2 Diesel is a complex mixture of hydrocarbons from a variety of chemical processes blended to meet standardized product specifications. Composition varies greatly and includes C9 to C20 hydrocarbons with a boiling range of about 325-675 degrees F. The following is a non-exhaustive list of common components, typical percentage ranges in product, and occupational exposure limits for each.

Component or Material Name	%	CAS Number	ACGIH Limits TLV -- STEL -- Units	OSHA Exposure Limits PEL -- STEL -- C/P -- Units
Cat cracked distillate, light	0-100	64741-59-9	100 -- NA -- mg/m3	N/A -- N/A -- N/A -- N/A
Hydrotreated distillate, middle	0-100	64742-46-7	100 -- NA -- mg/m3	N/A -- N/A -- N/A -- N/A
Hydrotreated distillate, light	0-100	64742-47-8	100 -- NA -- mg/m3	N/A -- N/A -- N/A -- N/A
Gas oil, light	0-100	64741-44-2	100 -- NA -- mg/m3	N/A -- N/A -- N/A -- N/A

3. Hazards Identification

Health Hazard Data:

1. The major effect of exposure to this product is giddiness, headache, central nervous system depression; possible irritation of eyes, nose, and lungs; and dermal irritation. Signs of kidney and liver damage may be delayed. Pulmonary irritation secondary to exhalation fo solvent.

2. NIOSH recommends that whole diesel engine exhaust be regarded as a potential occupational carcinogen. Follow OSHA and NSHA rules where diesel engine exhaust fumes may be generated.

3. A life time skin painting study by the American Petroleum Institute has shown that similar naphtha products with a boiling range of 350-700 degrees F usually produce skin tumors and/ or skin cancers in laboratory mice. Only a weak to moderate response occurred. The effect to humans has not been determined.

4. Positive results at 2.0 ml/kg and 6.0 ml/kg noted in mutagenesis studies via in-vivo bone marrow cytogenetics assay in rats.

5. Kerosene is classified as a severe skin irritant. Mutation data has been reported for kerosene products. Hydrotreated kerosene is listed as being probably carcinogenic to humans with limited evidence in humans and sufficient evidence in experimental animals.

Hazards of Combustion Products: Carbon monoxide and carbon dioxide can be found in the combustion products of this product and other forms of hydrocarbon combustion. Carbon monoxide in moderate concentrations can cause symptoms of headache, nausea, vomiting, increased cardiac output, and confusion. Exposure to higher concentrations of carbon monoxide can cause loss of consciousness, heart damage, brain damage, and/or death. Exposure to high concentrations of carbon dioxide can cause simple asphyxiation by displacing available oxygen. Combustion of this and other similar materials should only be carried out in well ventilated areas.

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MATERIAL SAFETY DATA SHEET

UNLEADED GASOLINE (UNBRANDED)

MSDS No.
APPC975
Version: 1

Date
05/19/2003

IMPORTANT: Read this MSDS before handling and disposing of this product and pass this information on to employees, customers, and users of this product.

1. PRODUCT and COMPANY IDENTIFICATION

Material Identity Unleaded Gasoline (Unbranded)

Trade Name(s) None

Other Name(s) Unleaded Motor Vehicle Gasoline, Unleaded Premium Gasoline, Unleaded Regular Gasoline or Petrol, Clear Gasoline.

Chemical Description Petroleum Hydrocarbons

Manufacturer's Address

BP West Coast Products LLC
Carson Business Unit
1801 E. Sepulveda Boulevard
Carson, California 90749-6210

BP West Coast Products LLC
Cherry Point Business Unit
4519 Grandview Road
Blaine, Washington 98230

Telephone Numbers

Emergency Health Information:	1 (800) 447-8735
Emergency Spill Information:	1 (800) 424-9300 CHEMTREC (USA)
Other Product Information:	1 (866) 4BP-MSDS (866-427-6737 Toll Free - North America) email: bpcares@bp.com
Customer Service:	1 (800) 322-3736 INFO

2. COMPONENTS and EXPOSURE LIMITS

Component[1]	CAS No.	% Composition By Volume[2]		Exposure Limits ACGIH TLV	OSHA PEL[3]	Units	Type
GASOLINE [(2)(4)]	8006-61-9	EQ	100	500	500	ppm	STEL
				300	300	ppm	TWA
which contains:							
BENZENE [(1)(2)(3)(4)]	71-43-2	AP	1 to 5	2.5	5	ppm	STEL
				0.5 skin	1	ppm	TWA
CYCLOHEXANE	110-82-7	LT	2	400	N/AP	ppm	STEL
				300	300	ppm	TWA
ETHYLBENZENE [(2)]	100-41-4	AP	1 to 3	125	125	ppm	STEL
				100	100	ppm	TWA
HEXANE (N-HEXANE)	110-54-3	AP	2 to 5	50 skin	50	ppm	TWA
TOLUENE	108-88-3	AP	7 to 14	N/AP	150	ppm	STEL
				50 skin	100	ppm	TWA
TRIMETHYL BENZENE (ALL ISOMERS)	25551-13-7	LT	5	25	25	ppm	TWA
1,2,4-TRIMETHYLBENZENE	95-63-6	AP	1 to 4	25	25	ppm	TWA

2,2,4 TRIMETHYLPENTANE							
	540-84-1	AP	3 to 10	N/AP	N/AP		
XYLENE							
	1330-20-7	AP	8 to 15	150	150	ppm	STEL
				100	100	ppm	TWA
which may contain:							
ETHANOL							
	64-17-5	AP	0 to 10	1000	1000	ppm	TWA
METHYL TERTIARY BUTYL ETHER (MTBE) (4)							
	1634-04-4	AP	0 to 15	40	N/AP	ppm	TWA

[1] Carcinogen displayed after Component Name. Listed by (1) NTP, (2) IARC, (3) OSHA, (4) Other

[2] See Abbreviations on last page

[3] The OSHA exposure limits were changed in 1993 due to a federal court ruling. ARCO has chosen to list the 1989 OSHA exposure limits in this document as they are generally more stringent and therefore more protective than the current exposure limits. (Refer to 29 CFR 1910.1000).

3. HAZARD IDENTIFICATION

IMMEDIATE HAZARDS

DANGER

HIGHLY FLAMMABLE! OSHA/NFPA Class IB flammable liquid. Keep away from heat, sparks, and open flame.

Never siphon gas by mouth. Harmful if swallowed. Contains petroleum distillates.

ASPIRATION HAZARD! If swallowed, do not induce vomiting since aspiration into the lungs may cause chemical pneumonia. Obtain prompt medical attention.

Prolonged or repeated liquid contact may cause irritation. High vapor concentrations (greater than 1000 ppm) may cause irritation to eyes and respiratory system and may cause dizziness and other nervous system effects.

Generally, human exposures to gasoline are considerably lower than levels which have caused adverse health effects in animal studies or human case studies of gasoline misuse or abuse (such as gasoline sniffing). Adverse health effects are not expected to occur at exposure levels typically encountered in the use of gasoline as a motor fuel.

Avoid breathing vapors or mists. Use only with adequate ventilation**.** Use as a motor fuel only. Do not use as a cleaning solvent, thinner or for other non-motor fuel use.

Wash hands thoroughly after handling.

ACUTE HEALTH HAZARDS

Routes of Exposure	Signs and Symptoms
Inhalation (Primary)	Exposures at airborne concentrations well above the recommended exposure limits in Section 2 may cause irritation of the nose, throat, and lungs, headache, dizziness, drowsiness, confusion, loss of coordination, fatigue, nausea, labored breathing and irregular heartbeats. May lead to unconsciousness, convulsions, and possibly death.
Eye Contact	May cause some transitory eye irritation but not expected to cause prolonged or significant eye irritation.
Skin Contact	Moderate skin irritation may occur upon short-term exposure. May be absorbed and contribute to the acute inhalation health effects (see above).
Ingestion	ASPIRATION HAZARD! This material can enter the lungs during swallowing or vomiting and may cause acute lung inflammation and damage which in severe cases may be fatal. Ingestion may cause irritation of the mouth, throat and gastrointestinal tract leading to nausea, vomiting, diarrhea, and restlessness. May cause headache, dizziness, drowsiness, confusion, loss of coordination, fatigue, nausea and labored breathing. May lead to unconsciousness, convulsions, and possibly death.

Summary of Chronic Hazards and Special Health Effects	Exposures at airborne concentrations well above the recommended exposure limits in Section 2 may aggravate medical conditions such as chronic respiratory diseases, cardiovascular disease, skin diseases, or blood disorders. Prolonged/repeated exposures above the recommended exposure limits via skin contact, inhalation or ingestion of this material may result in adverse dermal or systemic effects. Avoid prolonged or repeated overexposure. Contains benzene, a chemical known to cause cancer in humans. Repeated and prolonged overexposure to benzene vapors may cause leukemia, aplastic anemia, or other blood disorders, immunotoxicity, reproductive harm or fetal toxicity. Neurotoxic effects have been associated with n-hexane, a component of this material upon prolonged or repeated overexposure. Generally, human exposures to gasoline are considerably lower than levels which have caused adverse health effects in animal studies or human case studies of gasoline misuse or abuse (such as gasoline sniffing). Adverse health effects are not expected to occur at exposure levels typically encountered in the use of gasoline as a motor fuel. See Section 11 for Additional Toxicological Information.

4. EMERGENCY and FIRST AID

Inhalation	Immediately move personnel to area with fresh air. For respiratory distress, give oxygen, rescue breathing or administer CPR (cardiopulmonary resuscitation). Obtain prompt medical attention.
Eye Contact	Flush with clean, low-pressure water for at least 15 minutes, occasionally lifting the eyelids. If pain or redness is present after flushing, obtain medical attention.
Skin Contact	Immediately remove contaminated clothing. Wash affected skin thoroughly with soap and water. If irritation persists, obtain medical attention.
Ingestion	Do not induce vomiting. Obtain prompt medical attention. ASPIRATION HAZARD: This material can enter the lungs during swallowing or vomiting and may cause lung inflammation and damage.
Emergency Medical Treatment Procedures	See above procedures.

5. FIRE and EXPLOSION

Flash Point (Method)*		AP -45°F **	**NFPA Hazard Rating:**	
Autoignition Temperature (Method)*		AP 536°F **	**Health:**	1 = Slight
Flammable Limits (% Vol. in Air)*	**Lower**	AP 1.4	**Fire:**	3 = High
	Upper	AP 7.6	**Reactivity:**	0 = Insignificant
*** At Normal Atmospheric Temperature and Pressure**	**** Based on NFPA Gasoline**		**Special:**	= ---

Fire and Explosion Hazards	HIGHLY FLAMMABLE! Vaporizes easily at normal and below normal temperatures. When mixed with air in certain proportions and exposed to an ignition source, these vapors can burn in the open or explode in confined spaces. Being heavier than air, flammable vapors may travel long distances along the ground before reaching a point of ignition and flashing back. May accumulate static electricity. Liquid floats on water and may travel to a source of ignition and spread fire. “Empty” containers retain liquid and vapor residues and, if exposed to source of ignition, may explode.

Extinguishing Media
Foam, Water fog, Dry chemical, Carbon Dioxide (CO2)
Water and water spray may cool the fire but may not extinguish the fire.

Special Firefighting Procedures
For fires involving this material, do not enter any enclosed or confined fire space without proper protective equipment. This may include self-contained breathing apparatus to protect against the hazardous effects of combustion products and oxygen deficiencies. If firefighters cannot work upwind to the fire, respiratory protective equipment must be worn. Cool tanks and containers exposed to fire with water.

6. ACCIDENTAL RELEASE MEASURES

Precautions if Material is Spilled or Released
Eliminate all potential sources of ignition. Handling equipment and tools should be grounded to prevent sparking. Contain spill, evacuate non-essential personnel, and safely stop flow. Blanket spill with foam or use water fog to reduce vapor cloud. On hard surfaces, spilled material may create a slipping hazard. Equip cleanup crews with proper protective equipment (as specified in Section 8) and advise of hazards. Clean up by recovering as much spilled or contaminated materials as possible and placing into closed containers. Consult with an environmental professional for the federal, state and local cleanup and reporting requirements for spills and releases.

7. HANDLING and STORAGE

Handling, Storage and Decontamination Procedures
Avoid exposure to liquid and gas vapors. Odor is not a reliable warning of overexposure. Use only with adequate ventilation.

Keep away from sources of heat, flames, sparks or other ignition sources. Storage and use areas should be “No Smoking” areas. Containers should be bonded and grounded for transfers to avoid static sparks.

Outside or detached storage is preferred. Inside storage should be in a standard flammable liquids storage warehouse, room or cabinet. Separate from oxidizing materials.

Filling Portable Containers (less than 10 gallons) - to minimize static spark hazard:

1. Fill only metal containers or those approved to hold gasoline;
2. Place containers on the ground while dispensing fuel;
3. Keep hose nozzle in contact with the approved container during the entire filling process.

DO NOT fill any portable container in or on a vehicle.

“Empty” containers retain liquid and vapor residues and can be dangerous. Do not pressurize, cut, weld, drill, grind or expose to heat, flame, sparks, static electricity, or other sources of ignition containers with ANY residue; they may explode and cause injury or death.

For determining National Electrical Code (NEC) Hazardous (Classified) Location requirements for electrical installation, consider this material Class 1, Group D.

KEEP OUT OF REACH OF CHILDREN!

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Engineering Controls
Where possible, use adequate ventilation to keep vapor and mist concentrations of this material below the occupational exposure limits shown in Section 2. Electrical equipment should comply with National Electrical Code (NEC) standards (see Section 7).

Respiratory
A NIOSH/MSHA-approved air-purifying respirator with an organic vapor cartridge may be permissible under certain circumstances where airborne concentrations may exceed the exposure limits in Section 2. Consult a health and safety professional for guidance in respirator selection. Respirator use should comply with OSHA 29 CFR 1910.134.

	CAUTION: The protection provided by air-purifying respirators is limited. Use a positive pressure air-supplied respirator if there is any potential for an uncontrolled release, if exposure levels are not known, or if concentrations exceed the protection limits of the air-purifying respirator.
Eyes	Eye protection should be worn. If there is potential for splashing or spraying, chemical protective goggles and a face shield should be worn. If contact lenses are worn, consult an eye specialist or a safety professional for additional precautions. Suitable eye wash water should be available in case of eye contact with this material.
Skin	Avoid prolonged and/or repeated skin contact. If conditions or frequency of use make significant contact likely, clean and impervious clothing such as gloves, apron, boots and facial protection should be worn. Nitrile and Viton protective clothing material is recommended. Non-impervious clothing which becomes contaminated with this material should be removed promptly and not reworn until the material is effectively removed from the clothing.
Other Hygienic and Work Practices	Use good personal hygiene practices. In case of skin contact, wash with mild soap and water or a waterless hand cleaner. Wash hands and other exposed areas thoroughly before eating, drinking, smoking, or using toilet facilities.

9. PHYSICAL and CHEMICAL PROPERTIES

Boiling Point:	AP 35°F to 437°F
Viscosity Units, Temp. (Method):	N/AP
Dry Point:	AP 430°F
Freezing Point:	N/AP
Vapor Pressure, Temp. (Method):	AP 5 to 15 at 100°F (REID-PSIA)
Volatile Characteristics:	Appreciable
Specific Gravity (H_2O = 1 @ 39.2°F):	AP 0.7 to 0.8
Vapor Sp. Gr. (Air = 1.0 @ 60°F - 90°F):	AP 4
Solubility in Water:	Slight
PH:	N/AP
Appearance and Odor:	Colorless to straw-colored liquid; petroleum naphtha odor.
Other Physical and Chemical Properties:	Vapor pressure will vary seasonally in compliance with industry standards and federal and state regulations.

10. STABILITY and REACTIVITY

Stability	Stable
Hazardous Polymerization	Not expected to occur.
Other Chemical Reactivity	Reacts with oxidizing materials.

Conditions to Avoid	Heat, sparks, flame, and build up of static electricity.
Materials to Avoid	Halogens, strong acids, alkalies, and oxidizers.
Hazardous or Decomposition Products	Burning or excessive heating may produce carbon monoxide and other harmful gases or vapors including oxides and/or other compounds of sulfur. The inhalation of components of exhaust from combusted fuel can be fatal in high concentrations in an enclosed area. Exposure to exhaust from this fuel should be minimized.

11. TOXICOLOGICAL INFORMATION

Toxicological Information
The information found in this section is written for medical, toxicology, occupational health and safety professionals. This section provides technical information on the toxicity testing of this or similar materials or its components. If clarification of the technical content is needed, consult a professional in the areas of expertise listed above.

Inhalation
Toxicity studies on this material resulted in LC50 values greater than 5.0 mg/l indicating a low potency. There were signs of respiratory tract irritation and central nervous system depression.

Eye Contact
Minimal to no irritation in animal studies.

Skin Contact
Animal studies resulted in moderate skin irritation following short term or prolonged/repeated exposure. The acute dermal toxicity tests indicate LD50 values greater than 2.0 g/kg indicating a low potency. Exposure to sunlight does not increase skin irritation. This material appears to be non-sensitizing.

Ingestion
The acute oral toxicity tests produced LD50 values greater than 5.0 g/kg indicating a low potency. There were signs of gastrointestinal tract irritation and central nervous system depression.

Prolonged/ Repeated Exposures
Twenty-eight day dermal toxicity studies resulted in moderate skin irritation. In some studies changes in liver, kidney, testes and whole body weights were noted, but no significant systemic tissue changes characteristic of disease. Ninety-day dermal toxicity studies with similar material resulted in moderate skin irritation and not other significant observations or systemic tissue changes characteristic of disease. Twenty-eight day inhalation toxicity study similar materials resulted in kidney damage in male rats.

A two-year inhalation study with a generic unleaded gasoline formulated by the American Petroleum Institute caused kidney damage and kidney tumors in male rats and liver tumors in female mice. These effects are considered specific to these laboratory animals and not applicable to humans.

Exposure to components of gasoline such as benzene, toluene, xylene, ethylbenzene, trimethylbenzene, and N-hexane has also been shown to affect reproductive capacity and/or fetal development in laboratory animals.

Studies with laboratory animals (dogs) indicate that exposure to extremely high concentrations of gasoline (greater than 50,000 ppm) may cause irregular heartbeats and sudden death. Exposures of laboratory animals to some components of this material at very high concentrations, well above the recommended exposure limits in Section 2, have resulted in cardiac sensitization with irregular heartbeats.

Exposure to n-hexane at concentrations considerably higher than the current permissible exposure limit has reportedly been associated with peripheral neuropathy. Commercial hexane exposures up to 9000 ppm were not carcinogenic in laboratory animals.

In animal studies and in workers with chronic benzene poisoning, alterations in structure of chromosomes in bone marrow and white blood cells have been observed.

Additional Ethanol Toxicity Information
Exposures to ethanol in gasoline are considerably lower than levels which have caused adverse health effects. Adverse health effects are not expected to occur at exposure levels typically encountered in the use of ethanol as a gasoline additive.

Prolonged and repeated exposure to ethanol vapor above 1000 ppm may cause headache, lack of coordination, sleepiness, fatigue, and difficulty concentrating. Chronic ingestion of ethanol in the form of alcoholic beverages has resulted in liver, stomach, heart and nervous system damage as well as cancers of the mouth, pharynx, larynx, esophagus, and liver in humans. Repeated ingestion of ethanol in the form of alcoholic beverages by pregnant women has caused miscarriage, premature birth and low birth weight, and birth defects (fetal alcohol syndrome).

Additional MTBE Toxicity Information
MTBE at very high exposure levels (8000 ppm) did induce developmental toxicity in mice, but only at levels where there was also maternal toxicity. In rabbits exposed to the same MTBE levels, there were no indicators of any effects on the offspring, even in the presence of maternal toxicity. The abnormal findings in the mice (cleft palate, etc.) are well-recognized effects of stress in the pregnant mouse and have no correlation with development hazards in humans.

Chronic toxicity studies have been completed for MTBE. In these studies, B6C3Fl mice and F344 rats were exposed to 400, 3000, or 8000 ppm MTBE vapors, 6 hrs/day, 5 days/week for life. Few adverse effects were noted for either rats or mice.

Male and female mice exposed to 8000 ppm MTBE vapors developed a slightly higher incidence of benign liver tumors during their lifetime. No other adverse effects or increases in tumor incidences were found.

Male and female rats exposed to high concentrations of MTBE vapors developed an increasing incidence of chronic progressive kidney damage, an effect typically noted in aging rats. These effects were most severe in 3000 and 8000 ppm exposure groups and were accompanied by an increased incidence of kidney tumors (males only). These findings are consistent with kidney damage associated with accumulation of protein in cells, an effect which may be unique to the male rat. Benign testicular tumors were numerically increased in high dose MTBE male rats, but this is an age-related lesion which typically occurs in a very high proportion of control untreated rats.

MTBE does not appear to be a mutagen.

All of these effects either occur in tissues prone to the development of tumors or may occur by a mechanism not considered relevant to humans. The significance of these findings for human health hazards estimation is unclear. Furthermore, IARC has determined that MTBE is not classifiable as to its carcinogenicity to humans (Group 3).

12. ECOLOGICAL INFORMATION

Not Available

13. DISPOSAL CONSIDERATIONS

Waste Disposal Methods

Consult an environmental professional to determine if state or federal regulations would classify this material as a hazardous waste. Use only approved transporters, recyclers, treatment, storage or disposal facilities. Comply with all federal, state and local laws pertaining to waste management.

14. TRANSPORT INFORMATION

UN Proper Shipping Name	Gasoline
UN Hazard Class	3
UN Number	UN1203
UN Packing Group	PGII

15. REGULATORY INFORMATION

SUPERFUND AMENDMENTS AND REAUTHORIZATION ACT OF 1986 (SARA), TITLE III

Section 311/312 Hazard Categories:
Acute Health Hazard
Delayed (chronic) health hazard
Fire hazard

Section 313:
This product contains the following chemicals subject to the reporting requirements established by SARA Title III:

BENZENE
CYCLOHEXANE
ETHYLBENZENE
METHYL TERT-BUTYL ETHER
TOLUENE
XYLENE

TOXIC SUBSTANCES CONTROL ACT (TSCA)
All components of this product are listed on the TSCA Inventory.

COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION AND LIABILITY ACT (CERCLA)
This material is covered by CERCLA's PETROLEUM EXEMPTION.
(Refer to 40 CFR 307.14)

CALIFORNIA SAFE DRINKING WATER AND TOXIC ENFORCEMENT ACT OF 1986 - PROPOSITION 65

PROP 65 WARNING LABEL:
Chemicals known to the State to cause cancer, birth defects, or other reproductive harm are found in gasoline, crude oil, and many other petroleum products and their vapors, or result from their use. Read and follow label directions and use care when handling or using all petroleum products.

WARNING:
This product contains the following chemical(s) listed by the State of California as known to cause cancer or birth defects or other reproductive harm.

BENZENE [(C) (R)]
TOLUENE [(R)]

Other Prop 65 chemicals will result under certain conditions from the use of this material. For example, burning fuels produces combustion products including carbon monoxide, a Prop 65 reproductive toxin.

[(C)] **=** Carcinogen
[(R)] **=** Birth Defects or other Reproductive Harm

16. OTHER INFORMATION

General Comments

Because of volatility characteristics, gasoline vapors may have concentrations of components different from those of liquid gasoline. The major components of gasoline vapors from liquid gasoline are butane, isobutane, pentane and isopentane.

The information and conclusions herein reflect normal operating conditions and may be from sources other than direct test data on the mixture itself.

Abbreviations:	EQ = Equal	AP = Approximately	N/P = No Applicable Information Found
	LT = Less Than	UK = Unknown	N/AP = Not Applicable
	GT = Greater Than	TR = Trace	N/DA = No Data Available

Prepared by: Product Stewardship

Disclaimer of Liability
The information in this MSDS was obtained from sources which we believe are reliable. **HOWEVER, THE INFORMATION IS PROVIDED WITHOUT ANY WARRANTY, EXPRESS OR IMPLIED, REGARDING ITS CORRECTNESS.**

The conditions or methods of handling, storage, use and disposal of the product are beyond our control and may be beyond our knowledge. **FOR THIS AND OTHER REASONS, WE DO NOT ASSUME RESPONSIBILITY AND EXPRESSLY DISCLAIM LIABILITY FOR LOSS DAMAGE OR EXPENSE ARISING OUT OF OR IN ANY WAY CONNECTED WITH THE HANDLING, STORAGE, USE OR DISPOSAL OF THE PRODUCT.**

This MSDS was prepared and is to be used only for this product. If the product is used as a component in another product, this MSDS information may not be applicable.

Fisher Scientific
Part of Thermo Fisher Scientific

Material Safety Data Sheet

Hexane

ACC# 10951

Section 1 - Chemical Product and Company Identification

MSDS Name: Hexane
Product Grade : SQ, ExcelaR, HPLC
Catalog Numbers: 34205, 34206, 34207, 12815, 43586
Synonyms: Hexane, Hexane 65°C-70°C(95%) Fraction from Petroleum
Company Identification:

Fisher Scientific
Part of Thermo Fisher Scientific
THERMO ELECTRON LLS INDIA PVT.LTD.
Godrej Coliseum, 101A-101B, Somaiya Hospital Road,
Off Eastern Express Highway, Sion (East), Mumbai-400 022, India

For information, call: 022 – 6680 3001/2, **Call India Toll Free** – 1800 209 7001
Emergency Number: 022-66803004/14
For CHEMTREC assistance, call: 800-424-9300 [International]
For International CHEMTREC assistance, call: 703-527-3887 [International]

Section 2 - Composition, Information on Ingredients

CAS#	Chemical Name	Percent	EINECS/ELINCS
110-54-3	Hexane (contains a mixture of isomers)	100	203-777-6

Section 3 - Hazards Identification

EMERGENCY OVERVIEW

Appearance: clear colorless liquid.
Danger! Extremely flammable liquid and vapor. Vapor may cause flash fire. Breathing vapors may cause drowsiness and dizziness. Causes eye, skin, and respiratory tract irritation. May be harmful if absorbed through the skin. Aspiration hazard if swallowed. Can enter lungs and cause damage. Possible risk of impaired fertility. Long-term exposure may cause damage to the nervous system of the extremities (the hands, arms, legs and feet). Dangerous for the environment.
Target Organs: Central nervous system, respiratory system, eyes, skin, peripheral

nervous system, testes.

Potential Health Effects

Eye: Causes mild eye irritation.
Skin: Prolonged and/or repeated contact may cause defatting of the skin and dermatitis. Causes irritation with burning pain, itching, and redness. Absorbed through the skin. There have been no reports of skin sensitization in people occupationally exposed to n-hexane. Skin sensitization was not observed in a maximization test using 25 volunteers.
Ingestion: May cause gastrointestinal irritation with nausea, vomiting and diarrhea. Aspiration of material into the lungs may cause chemical pneumonitis, which may be fatal. May cause central nervous system depression.
Inhalation: Causes respiratory tract irritation. Exposure produces central nervous system depression. Vapors may cause dizziness or suffocation. n-Hexane vapor concentrations can become so high that oxygen is displaced, especially in confined spaces.
Chronic: Prolonged or repeated skin contact may cause defatting and dermatitis. Prolonged or repeated exposure may cause adverse reproductive effects. Chronic exposure may cause visual disturbances. Laboratory experiments have resulted in mutagenic effects. Peripheral neuropathy symptoms include: muscular weakness, paresthesia, numbing of the hands, feet, legs and arms, unsteadiness, and difficulty in walking and standing. Repeated exposure may cause nervous system abnormalities with muscle weakness and damage, motor incoordination, and sensation disturbances. Chronic exposure produces peripheral neuropathy.

Section 4 - First Aid Measures

Eyes: In case of contact, immediately flush eyes with plenty of water for a t least 15 minutes. Get medical aid.
Skin: In case of contact, flush skin with plenty of water. Remove contaminated clothing and shoes. Get medical aid if irritation develops and persists. Wash clothing before reuse.
Ingestion: Potential for aspiration if swallowed. Get medical aid immediately. Do not induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. If vomiting occurs naturally, have victim lean forward.
Inhalation: If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical aid.
Notes to Physician: Treat symptomatically and supportively. For ingestion, the stomach sould be intubated, aspirated, and lavaged with a slurry of activated charcoal--protect the airway from aspiration of gastric contents. Monitor arterial blood gases in cases of severe aspiration.

Section 5 - Fire Fighting Measures

General Information: As in any fire, wear a self-contained breathing apparatus in pressure-demand, MSHA/NIOSH (approved or equivalent), and full protective gear. During a fire, irritating and highly toxic gases may be generated by thermal decomposition or combustion. Use water spray to keep fire-exposed containers cool. May accumulate static electrical charges, and may cause ignition of its own vapors. Extremely flammable liquid and vapor. Vapor may cause flash fire. Vapors are heavier than air and may travel to a source of ignition and flash back. Vapors can spread along the ground and collect in low or confined areas. This liquid floats on water and may travel to a source of ignition and spread fire.
Extinguishing Media: Use dry chemical, carbon dioxide, or appropriate foam. Solid streams of water may be ineffective and spread material. Water may be ineffective because it will not cool material below its flash point.
Flash Point: -22 to -26.1 de
Autoignition Temperature: 225 deg C (437.00 deg F)
Explosion Limits, Lower:1.2 vol %
Upper: 7.7 vol %
NFPA Rating: (estimated) Health: 2; Flammability: 3; Instability: 0

Section 6 - Accidental Release Measures

General Information: Use proper personal protective equipment as indicated in Section 8.
Spills/Leaks: Absorb spill with inert material (e.g. vermiculite, sand or earth), then place in suitable container. Avoid runoff into storm sewers and ditches which lead to waterways. Clean up spills immediately, observing precautions in the Protective Equipment section. Remove all sources of ignition. Provide ventilation. A vapor suppressing foam may be used to reduce vapors. Use only non-sparking tools and equipment.

Section 7 - Handling and Storage

Handling: Wash thoroughly after handling. Remove contaminated clothing and wash before reuse. Ground and bond containers when transferring material. Avoid contact with eyes, skin, and clothing. Empty containers retain product residue, (liquid and/or vapor), and can be dangerous. Take precautionary measures against static discharges. Keep away from heat, sparks and flame. Do not pressurize, cut, weld, braze, solder, drill, grind, or expose empty containers to heat, sparks or open flames. Use only with adequate ventilation. Avoid breathing vapor or mist.
Storage: Keep away from heat and flame. Keep away from sources of ignition. Store in

a tightly closed container. Keep from contact with oxidizing materials. Store in a cool, dry, well-ventilated area away from incompatible substances. Flammables-area.

Section 8 - Exposure Controls, Personal Protection

Engineering Controls: Facilities storing or utilizing this material should be equipped with an eyewash facility and a safety shower. Use adequate general or local explosion-proof ventilation to keep airborne levels to acceptable levels.
Exposure Limits

Chemical Name	ACGIH	NIOSH	OSHA - Final PELs
Hexane (contains a mixture of isomers)	50 ppm TWA; Skin - potential significant contribution to overall exposure by the cutaneous r oute	50 ppm TWA; 180 mg/m3 TWA 1100 ppm IDLH	500 ppm TWA; 1800 mg/m3 TWA

OSHA Vacated PELs: Hexane (contains a mixture of isomers): 50 ppm TWA; 180 mg/m3 TWA
Personal Protective Equipment
Eyes: Wear chemical splash goggles.
Skin: Wear appropriate protective gloves to prevent skin exposure.
Clothing: Wear appropriate protective clothing to prevent skin exposure.
Respirators: A respiratory protection program that meets OSHA's 29 CFR 1910.134 and ANSI Z88.2 requirements or European Standard EN 149 must be followed whenever workplace conditions warrant respirator use.

Section 9 - Physical and Chemical Properties

Physical State: Liquid
Appearance: clear colorless
Odor: gasoline-like
pH: Not available.
Vapor Pressure: 151 mm Hg @ 25 deg C
Vapor Density: 2.97(Air = 1)
Evaporation Rate: Not available.
Viscosity: 0.31 mPas 20 deg C
Boiling Point: 62 - 69 deg C @ 760 mmHg
Freezing/Melting Point:-95 deg C
Decomposition Temperature: Not available.
Solubility: Insoluble.

Specific Gravity/Density:0.678
Molecular Formula:C6H14
Molecular Weight:86.18

Section 10 - Stability and Reactivity

Chemical Stability: Stable under normal temperatures and pressures.
Conditions to Avoid: Ignition sources, excess heat, electrical sparks, confined spaces.
Incompatibilities with Other Materials: Strong oxidizing agents.
Hazardous Decomposition Products: Carbon monoxide, carbon dioxide.
Hazardous Polymerization: Will not occur.

Section 11 - Toxicological Information

RTECS#:
CAS# 110-54-3: MN9275000
LD50/LC50:
CAS# 110-54-3:
Draize test, rabbit, eye: 10 mg Mild;
Inhalation, mouse: LC50 = 150000 mg/m3/2H;
Inhalation, rat: LC50 = 48000 ppm/4H;
Inhalation, rat: LC50 = 627000 mg/m3/3M;
Oral, rat: LD50 = 25 gm/kg;
.

Carcinogenicity:
CAS# 110-54-3: Not listed by ACGIH, IARC, NTP, or CA Prop 65.

Epidemiology: Occupational polyneuropathy has resulted from hexane exposures as low as 500 ppm, but the minimum levels of n-hexane that are neurotoxic in humans haven't been established. Nearly continuous exposure of animals at 250 ppm has caused neurotoxic effects.
Teratogenicity: No evidence of teratogenicity or embryotoxicity in anmial studies with hexane. Fetotoxicity has been observed in the presence of maternal toxicity.
Reproductive Effects: Severe testicular damage has been observed in rats exposed to hexane at concentrations which have produced other significant toxicity. Although subneurotoxic doses of its principle toxic metabolite, 2,5-hexanedione, can induce progressive testiculartoxicity in rats, there have been no reports of human sterility or other reproductive toxicity associated with n-hexane exposures.
Mutagenicity: Positive results (chromosomal damage in the bone marrow cells) obtained for rats exposed by inhalation to n-hexane.
Neurotoxicity: n-Hexane is a mild irritant and CNS depressant in acute exposure, but

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www.fishersci.com

its principal effects are damage to the sensory and motor peripheral nerves, particularly in chronic exposure.
Other Studies:

Section 12 - Ecological Information

Ecotoxicity: No data available. Estimated BCF values = 2.24 and 2.89. These values suggest that hexane will show low bioconcentration in aquatic organisms. Estimated Koc value = 4.11. This product will show slight soil mobility and is expected to rapidly volatilize from moist surface soils.
Environmental: Terrestrial: Volatilization and adsorption are expected to be the most important fate processes. Aquatic: Photolysis or hydrolysis are not expected to be important. Atmospheric: Expected to exist entirely in the vapor phase in ambient air, expected half life 2.8 days. Expected to biodegrade but not bioconcentrate.
Physical: No information available.
Other: No information available.

Section 13 - Disposal Considerations

Chemical waste generators must determine whether a discarded chemical is classified as a hazardous waste. US EPA guidelines for the classification determination are listed in 40 CFR Parts 261.3. Additionally, waste generators must consult state and local hazardous waste regulations to ensure complete and accurate classification.
RCRA P-Series: None listed.
RCRA U-Series: None listed.

Section 14 - Transport Information

	US DOT	Canada TDG
Shipping Name:	HEXANES	HEXANES
Hazard Class:	3	3
UN Number:	UN1208	UN1208
Packing Group:	II	II
Additional Info:		FLASHPOINT -22C

Section 15 - Regulatory Information

US FEDERAL

TSCA
CAS# 110-54-3 is listed on the TSCA inventory.
Health & Safety Reporting List
None of the chemicals are on the Health & Safety Reporting List.
Chemical Test Rules
None of the chemicals in this product are under a Chemical Test Rule.
Section 12b
None of the chemicals are listed under TSCA Section 12b.
TSCA Significant New Use Rule
None of the chemicals in this material have a SNUR under TSCA.
CERCLA Hazardous Substances and corresponding RQs
CAS# 110-54-3: 5000 lb final RQ; 2270 kg final RQ
SARA Section 302 Extremely Hazardous Substances
None of the chemicals in this product have a TPQ.
SARA Codes
CAS # 110-54-3: immediate, delayed, fire.
Section 313
This material contains Hexane (contains a mixture of (CAS# 110-54-3, 100%),which is subject to the reporting requirements of Section 313 of SARA Title III and 40 CFR
Clean Air Act:
CAS# 110-54-3 is listed as a hazardous air pollutant (HAP).
This material does not contain any Class 1 Ozone depletors.
This material does not contain any Class 2 Ozone depletors.
Clean Water Act:
None of the chemicals in this product are listed as Hazardous Substances under the CWA.
None of the chemicals in this product are listed as Priority Pollutants under the CWA.
None of the chemicals in this product are listed as Toxic Pollutants under the CWA.
OSHA:
None of the chemicals in this product are considered highly hazardous by OSHA.
STATE
CAS# 110-54-3 can be found on the following state right to know lists: New Jersey, Pennsylvania, Minnesota, Massachusetts.

California Prop 65

California No Significant Risk Level: None of the chemicals in this product are listed.

European/International Regulations
European Labeling in Accordance with EC Directives
Hazard Symbols:
XN F N
Risk Phrases:

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R 11 Highly flammable.
R 38 Irritating to skin.
R 48/20 Harmful : danger of serious damage to health by prolonged exposure through inhalation.
R 62 Possible risk of impaired fertility.
R 51/53 Toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment.
R 65 Harmful: may cause lung damage if swallowed.
R 67 Vapours may cause drowsiness and dizziness.

Safety Phrases:
S 16 Keep away from sources of ignition - No smoking.
S 29 Do not empty into drains.
S 33 Take precautionary measures against static discharges.
S 36/37 Wear suitable protective clothing and gloves.
S 9 Keep container in a well-ventilated place.
S 61 Avoid release to the environment. Refer to special instructions /safety data sheets.
S 62 If swallowed, do not induce vomiting: seek medical advice immed iately and show this container or label.

WGK (Water Danger/Protection)
CAS# 110-54-3: 1
Canada - DSL/NDSL
CAS# 110-54-3 is listed on Canada's DSL List.
Canada - WHMIS
This product has a WHMIS classification of B2, D2B.
This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations and the MSDS contains all of the information required by those regulations.
Canadian Ingredient Disclosure List
CAS# 110-54-3 is listed on the Canadian Ingredient Disclosure List.

Section 16 - Additional Information

MSDS Creation Date: 6/03/1999
Revision #14 Date: 10/25/2007

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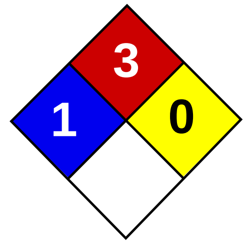
Chemicals & Laboratory Equipment



Health	2
Fire	3
Reactivity	0
Personal Protection	H

Material Safety Data Sheet
Isopropyl alcohol MSDS

Section 1: Chemical Product and Company Identification

Product Name: Isopropyl alcohol

Catalog Codes: SLI1153, SLI1579, SLI1906, SLI1246, SLI1432

CAS#: 67-63-0

RTECS: NT8050000

TSCA: TSCA 8(b) inventory: Isopropyl alcohol

CI#: Not available.

Synonym: 2-Propanol

Chemical Name: isopropanol

Chemical Formula: C3-H8-O

Contact Information:

Sciencelab.com, Inc.
14025 Smith Rd.
Houston, Texas 77396

US Sales: **1-800-901-7247**
International Sales: **1-281-441-4400**

Order Online: ScienceLab.com

CHEMTREC (24HR Emergency Telephone), call:
1-800-424-9300

International CHEMTREC, call: 1-703-527-3887

For non-emergency assistance, call: 1-281-441-4400

Section 2: Composition and Information on Ingredients

Composition:

Name	CAS #	% by Weight
Isopropyl alcohol	67-63-0	100

Toxicological Data on Ingredients: Isopropyl alcohol: ORAL (LD50): Acute: 5045 mg/kg [Rat]. 3600 mg/kg [Mouse]. 6410 mg/kg [Rabbit]. DERMAL (LD50): Acute: 12800 mg/kg [Rabbit].

Section 3: Hazards Identification

Potential Acute Health Effects:
Hazardous in case of eye contact (irritant), of ingestion, of inhalation. Slightly hazardous in case of skin contact (irritant, sensitizer, permeator).

Potential Chronic Health Effects:
Slightly hazardous in case of skin contact (sensitizer). CARCINOGENIC EFFECTS: A4 (Not classifiable for human or animal.) by ACGIH, 3 (Not classifiable for human.) by IARC. MUTAGENIC EFFECTS: Not available. TERATOGENIC EFFECTS: Not available. DEVELOPMENTAL TOXICITY: Classified Reproductive system/toxin/female, Development toxin [POSSIBLE]. The substance may be toxic to kidneys, liver, skin, central nervous system (CNS). Repeated or prolonged exposure to the substance can produce target organs damage.

Section 4: First Aid Measures

Eye Contact:
Check for and remove any contact lenses. In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Cold water may be used. Get medical attention.

Skin Contact:
Wash with soap and water. Cover the irritated skin with an emollient. Get medical attention if irritation develops. Cold water may be used.

Serious Skin Contact: Not available.

Inhalation:
If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention if symptoms appear.

Serious Inhalation:
Evacuate the victim to a safe area as soon as possible. Loosen tight clothing such as a collar, tie, belt or waistband. If breathing is difficult, administer oxygen. If the victim is not breathing, perform mouth-to-mouth resuscitation. Seek medical attention.

Ingestion:
Do NOT induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. Loosen tight clothing such as a collar, tie, belt or waistband. Get medical attention if symptoms appear.

Serious Ingestion: Not available.

Section 5: Fire and Explosion Data

Flammability of the Product: Flammable.

Auto-Ignition Temperature: 399°C (750.2°F)

Flash Points: CLOSED CUP: 11.667°C (53°F) - 12.778 deg. C (55 deg. F) (TAG)

Flammable Limits: LOWER: 2% UPPER: 12.7%

Products of Combustion: These products are carbon oxides (CO, CO2).

Fire Hazards in Presence of Various Substances:
Highly flammable in presence of open flames and sparks, of heat. Flammable in presence of oxidizing materials. Non-flammable in presence of shocks.

Explosion Hazards in Presence of Various Substances:
Risks of explosion of the product in presence of mechanical impact: Not available. Explosive in presence of open flames and sparks, of heat.

Fire Fighting Media and Instructions:
Flammable liquid, soluble or dispersed in water. SMALL FIRE: Use DRY chemical powder. LARGE FIRE: Use alcohol foam, water spray or fog.

Special Remarks on Fire Hazards:
Vapor may travel considerable distance to source of ignition and flash back. CAUTION: MAY BURN WITH NEAR INVISIBLE FLAME. Hydrogen peroxide sharply reduces the autoignition temperature of Isopropyl alcohol. After a delay, Isopropyl alcohol ignites on contact with dioxgenyl tetrafluorborate, chromium trioxide, and potassium tert-butoxide. When heated to decomposition it emits acrid smoke and fumes.

Special Remarks on Explosion Hazards:
Secondary alcohols are readily autooxidized in contact with oxygen or air, forming ketones and hydrogen peroxide. It can become potentially explosive. It reacts with oxygen to form dangerously unstable peroxides which can concentrate and explode during distillation or evaporation. The presence of 2-butanone increases the reaction rate for peroxide formation. Explosive in the form of vapor when exposed to heat or flame. May form explosive mixtures with air. Isopropyl alcohol + phosgene forms isopropyl chloroformate and hydrogen chloride. In the presence of iron salts, thermal decompositon can occur, whicn in some cases can become explosive. A homogeneous mixture of concentrated peroxides + isopropyl alcohol are capable of detonation by shock or heat. Barium perchlorate + isopropyl alcohol gives the highly explosive alkyl perchlorates.

It forms explosive mixtures with trinitormethane and hydrogen peroxide. It produces a violent explosive reaction when heated with aluminum isopropoxide + crotonaldehyde. Mixtures of isopropyl alcohol + nitroform are explosive.

Small Spill:
Dilute with water and mop up, or absorb with an inert dry material and place in an appropriate waste disposal container.

Large Spill:
Flammable liquid. Keep away from heat. Keep away from sources of ignition. Stop leak if without risk. Absorb with DRY earth, sand or other non-combustible material. Do not touch spilled material. Prevent entry into sewers, basements or confined areas; dike if needed. Be careful that the product is not present at a concentration level above TLV. Check TLV on the MSDS and with local authorities.

Precautions:
Keep away from heat. Keep away from sources of ignition. Ground all equipment containing material. Do not ingest. Do not breathe gas/fumes/ vapor/spray. Avoid contact with eyes. Wear suitable protective clothing. In case of insufficient ventilation, wear suitable respiratory equipment. If ingested, seek medical advice immediately and show the container or the label. Keep away from incompatibles such as oxidizing agents, acids.

Storage:
Store in a segregated and approved area. Keep container in a cool, well-ventilated area. Keep container tightly closed and sealed until ready for use. Avoid all possible sources of ignition (spark or flame).

Engineering Controls:
Provide exhaust ventilation or other engineering controls to keep the airborne concentrations of vapors below their respective threshold limit value. Ensure that eyewash stations and safety showers are proximal to the work-station location.

Personal Protection:
Splash goggles. Lab coat. Vapor respirator. Be sure to use an approved/certified respirator or equivalent. Gloves.

Personal Protection in Case of a Large Spill:
Splash goggles. Full suit. Vapor respirator. Boots. Gloves. A self contained breathing apparatus should be used to avoid inhalation of the product. Suggested protective clothing might not be sufficient; consult a specialist BEFORE handling this product.

Exposure Limits:
TWA: 983 STEL: 1230 (mg/m3) [Australia] TWA: 200 STEL: 400 (ppm) from ACGIH (TLV) [United States] [1999] TWA: 980 STEL: 1225 (mg/m3) from NIOSH TWA: 400 STEL: 500 (ppm) from NIOSH TWA: 400 STEL: 500 (ppm) [United Kingdom (UK)] TWA: 999 STEL: 1259 (mg/m3) [United Kingdom (UK)] TWA: 400 STEL: 500 (ppm) from OSHA (PEL) [United States] TWA: 980 STEL: 1225 (mg/m3) from OSHA (PEL) [United States]Consult local authorities for acceptable exposure limits.

Section 9: Physical and Chemical Properties

Physical state and appearance: Liquid.

Odor:
Pleasant. Odor resembling that of a mixture of ethanol and acetone.

Taste: Bitter. (Slight.)

Molecular Weight: 60.1 g/mole

Color: Colorless.

pH (1% soln/water): Not available.

Boiling Point: 82.5°C (180.5°F)

Melting Point: -88.5°C (-127.3°F)

Critical Temperature: 235°C (455°F)

Specific Gravity: 0.78505 (Water = 1)

Vapor Pressure: 4.4 kPa (@ 20°C)

Vapor Density: 2.07 (Air = 1)

Volatility: Not available.

Odor Threshold:
22 ppm (Sittig, 1991) 700 ppm for unadapted panelists (Verschuren, 1983).

Water/Oil Dist. Coeff.: The product is equally soluble in oil and water; log(oil/water) = 0.1

Ionicity (in Water): Not available.

Dispersion Properties: See solubility in water, methanol, diethyl ether, n-octanol, acetone.

Solubility:
Easily soluble in cold water, hot water, methanol, diethyl ether, n-octanol, acetone. Insoluble in salt solution. Soluble in benzene. Miscible with most organic solvents including alcohol, ethyl alcohol, chloroform.

Stability: The product is stable.

Instability Temperature: Not available.

Conditions of Instability: Heat, Ignition sources, incompatible materials

Incompatibility with various substances: Reactive with oxidizing agents, acids, alkalis.

Corrosivity: Non-corrosive in presence of glass.

Special Remarks on Reactivity:
Reacts violently with hydrogen + palladium combination, nitroform, oleum, COCl2, aluminum triisopropoxide, oxidants Incompatible with acetaldehyde, chlorine, ethylene oxide, isocyanates, acids, alkaline earth, alkali metals, caustics, amines, crotonaldehyde, phosgene, ammonia. Isopropyl alcohol reacts with metallic aluminum at high temperatures. Isopropyl alcohol attacks some plastics, rubber, and coatings. Vigorous reaction with sodium dichromate + sulfuric acid.

Special Remarks on Corrosivity: May attack some forms of plastic, rubber and coating

Polymerization: Will not occur.

Section 11: Toxicological Information

Routes of Entry: Absorbed through skin. Dermal contact. Eye contact. Inhalation.

Toxicity to Animals:
WARNING: THE LC50 VALUES HEREUNDER ARE ESTIMATED ON THE BASIS OF A 4-HOUR EXPOSURE. Acute oral toxicity (LD50): 3600 mg/kg [Mouse]. Acute dermal toxicity (LD50): 12800 mg/kg [Rabbit]. Acute toxicity of the vapor (LC50): 16000 8 hours [Rat].

Chronic Effects on Humans:
CARCINOGENIC EFFECTS: A4 (Not classifiable for human or animal.) by ACGIH, 3 (Not classifiable for human.) by IARC. DEVELOPMENTAL TOXICITY: Classified Reproductive system/toxin/female, Development toxin [POSSIBLE]. May cause damage to the following organs: kidneys, liver, skin, central nervous system (CNS).

Other Toxic Effects on Humans:
Hazardous in case of ingestion, of inhalation. Slightly hazardous in case of skin contact (irritant, sensitizer, permeator).

Special Remarks on Toxicity to Animals: Not available.

Special Remarks on Chronic Effects on Humans:
M a y c a u s e a d v e r s e r e p r o d u c t i v e / t e r a t o g e n i c e f f e c t s (f e r t i l i t y , f e t o x i c i t y , d e v e l o p m e n t a l abnormalities(developmental toxin)) based on animal studies. Detected in maternal milk in human.

Special Remarks on other Toxic Effects on Humans:
Acute Potential Health Effects: Skin: May cause mild skin irritation, and sensitization. Eyes: Can cause eye irritation. Inhalation: Breathing in small amounts of this material during normal handling is not likely to cause harmful effects. However, breathing large amounts may be harmful and may affect the respiratory system and mucous membranes (irritation), behavior and brain (Central nervous system depression - headache, dizziness, drowsiness, stupor, incoordination, unconciousness, coma and possible death), peripheral nerve and senstation, blood, urinary system, and liver. Ingestion: Swallowing small amouts during normal handling is not likely to cause harmful effects. Swallowing large amounts may be harmful. Swallowing large amounts may cause gastrointestinal tract irritation with nausea, vomiting and diarrhea, abdominal pain. It also may affect the urinary system, cardiovascular system, sense organs, behavior or central nervous system (somnolence, generally depressed activity, irritability, headache, dizziness, drowsiness), liver, and respiratory system (breathing difficulty). Chronic Potential Health Effects: May cause defatting of the skin and dermatitis and allergic reaction. May cause adverse reproductive effects based on animal data (studies).

Section 12: Ecological Information

Ecotoxicity: Ecotoxicity in water (LC50): 100000 mg/l 96 hours [Fathead Minnow]. 64000 mg/l 96 hours [Fathead Minnow].

BOD5 and COD: Not available.

Products of Biodegradation:
Possibly hazardous short term degradation products are not likely. However, long term degradation products may arise.

Toxicity of the Products of Biodegradation: The product itself and its products of degradation are not toxic.

Special Remarks on the Products of Biodegradation: Not available.

Section 13: Disposal Considerations

Waste Disposal:
Waste must be disposed of in accordance with federal, state and local environmental control regulations.

Section 14: Transport Information

DOT Classification: CLASS 3: Flammable liquid.

Identification: : Isopropyl Alcohol UNNA: 1219 PG: II

Special Provisions for Transport: Not available.

Section 15: Other Regulatory Information

Federal and State Regulations:
Connecticut hazardous material survey.: Isopropyl alcohol Illinois toxic substances disclosure to employee act: Isopropyl alcohol Rhode Island RTK hazardous substances: Isopropyl alcohol Pennsylvania RTK: Isopropyl alcohol Florida: Isopropyl alcohol Minnesota: Isopropyl alcohol Massachusetts RTK: Isopropyl alcohol New Jersey: Isopropyl alcohol New Jersey spill list: Isopropyl alcohol Director's list of Hazardous Substances: Isopropyl alcohol Tennesee: Isopropyl alcohol TSCA 8(b) inventory: Isopropyl alcohol TSCA 4(a) final testing order: Isopropyl alcohol TSCA 8(a) IUR: Isopropyl alcohol TSCA 8(d) H

and S data reporting: Isopropyl alcohol: Effective date: 12/15/86 Sunset Date: 12/15/96 TSCA 12(b) one time export: Isopropyl alcohol SARA 313 toxic chemical notification and release reporting: Isopropyl alcohol

Other Regulations:
OSHA: Hazardous by definition of Hazard Communication Standard (29 CFR 1910.1200). EINECS: This product is on the European Inventory of Existing Commercial Chemical Substances.

Other Classifications:

WHMIS (Canada):
CLASS B-2: Flammable liquid with a flash point lower than 37.8°C (100°F). CLASS D-2B: Material causing other toxic effects (TOXIC).

DSCL (EEC):
R11- Highly flammable. R36- Irritating to eyes. S7- Keep container tightly closed. S16- Keep away from sources of ignition - No smoking. S24/25- Avoid contact with skin and eyes. S26- In case of contact with eyes, rinse immediately with plenty of water and seek medical advice.

HMIS (U.S.A.):

Health Hazard: 2

Fire Hazard: 3

Reactivity: 0

Personal Protection: h

National Fire Protection Association (U.S.A.):

Health: 1

Flammability: 3

Reactivity: 0

Specific hazard:

Protective Equipment:
Gloves. Lab coat. Vapor respirator. Be sure to use an approved/certified respirator or equivalent. Wear appropriate respirator when ventilation is inadequate. Splash goggles.

Section 16: Other Information

References: Not available.

Other Special Considerations: Not available.

Created: 10/09/2005 05:53 PM

Last Updated: 05/21/2013 12:00 PM

LIQUINOX MSDS

Section 1 : MANUFACTURER INFORMATION

Supplier: Same as manufacturer.

Manufacturer: Alconox, Inc.
30 Glenn St.
Suite 309
White Plains, NY 10603.

Manufacturer emergency phone number: 800-255-3924.
813-248-0585 (outside of the United States).

Manufacturer: Alconox, Inc.
30 Glenn St.
Suite 309
White Plains, NY 10603.

Supplier MSDS date: 2005/02/24

D.O.T. Classification: Not regulated.

Section 2 : HAZARDOUS INGREDIENTS

C.A.S.	CONCENTRATION %	Ingredient Name	T.L.V.	LD/50	LC/50
25155-30-0	10-30	SODIUM DODECYLBENZENESULFONATE	NOT AVAILABLE	438 MG/KG RAT ORAL 1330 MG/KG MOUSE ORAL	NOT AVAILABLE

Section 3 : PHYSICAL / CHEMICAL CHARACTERISTICS

Physical state: Liquid.

Appearance & odor: Odourless.
Pale yellow.

Odor threshold (ppm): Not available.

Vapour pressure (mmHg): @ 20°C (68°F).
17

Vapour density (air=1): >1

<u>Volatiles (%)</u>

By volume: Not available.

Evaporation rate (butyl acetate = 1): < 1.

Boiling point (°C):	100 (212F)
Freezing point (°C):	Not available.
pH:	8.5
Specific gravity @ 20 °C:	(water = 1). 1.083
Solubility in water (%):	Complete.
Coefficient of water\oil dist.:	Not available.
VOC:	None

Section 4 : FIRE AND EXPLOSION HAZARD DATA

Flammability:	Not flammable.
Conditions of flammability:	Surrounding fire.
Extinguishing media:	Carbon dioxide, dry chemical, foam. Water Water fog.
Special procedures:	Self-contained breathing apparatus required. Firefighters should wear the usual protective gear. Use water spray to cool fire exposed containers.
Auto-ignition temperature:	Not available.
Flash point (°C), method:	None
Lower flammability limit (% vol):	Not applicable.
Upper flammability limit (% vol):	Not applicable.

Not available.

Sensitivity to mechanical impact:	Not available.
Hazardous combustion products:	Oxides of carbon (COx). Hydrocarbons.
Rate of burning:	Not available.
Explosive power:	Containers may rupture if exposed to heat or fire.

Section 5 : REACTIVITY DATA

Chemical stability:	Product is stable under normal handling and storage conditions.
Conditions of instability:	Extreme temperatures.
Hazardous polymerization:	Will not occur.
Incompatible substances:	Strong acids. Strong oxidizing agents.
Hazardous decomposition products:	See hazardous combustion products.

Section 6 : HEALTH HAZARD DATA

Route of entry:	Skin contact, eye contact, inhalation and ingestion.
Effects of Acute Exposure	
Eye contact:	May cause irritation.
Skin contact:	Prolonged and repeated contact may cause irritation.
Inhalation:	May cause headache and nausea.
Ingestion:	May cause vomiting and diarrhea. May cause gastric distress.
Effects of chronic exposure:	See effects of acute exposure.
LD50 of product, species & route:	> 5000 mg/kg rat oral.
LC50 of product, species & route:	Not available.
Exposure limit of material:	Not available.
Sensitization to product:	Not available.
Carcinogenic effects:	Not listed as a carcinogen.
Reproductive effects:	Not available.
Teratogenicity:	Not available.
Mutagenicity:	Not available.
Synergistic materials:	Not available.
Medical conditions aggravated by exposure:	Not available.
First Aid	
Skin contact:	Remove contaminated clothing. Wash thoroughly with soap and water. Seek medical attention if irritation persists.
Eye contact:	Check for and remove contact lenses. Flush eyes with clear, running water for 15 minutes while holding eyelids open: if irritation persists, consult a physician.
Inhalation:	Remove victim to fresh air. If irritation persists, seek medical attention.
Ingestion:	Do not induce vomiting, seek medical attention. Dilute with two glasses of water. Never give anything by mouth to an unconscious person.

Section 7 : PRECAUTIONS FOR SAFE HANDLING AND USE

Leak / Spill:	Contain the spill. Prevent entry into drains, sewers, and other waterways. Wear appropriate protective equipment. Small amounts may be flushed to sewer with water. Soak up with an absorbent material. Place in appropriate container for disposal. Notify the appropriate authorities as required.
Waste disposal:	In accordance with local and federal regulations.
Handling procedures and equipment:	Protect against physical damage. Avoid breathing vapors/mists. Wear personal protective equipment appropriate to task.

Wash thoroughly after handling.
Keep out of reach of children.
Avoid contact with skin, eyes and clothing.
Avoid extreme temperatures.
Launder contaminated clothing prior to reuse.

Storage requirements: Store away from incompatible materials.
Keep containers closed when not in use.

Section 8 : CONTROL MEASURES

Precautionary Measures

Gloves / Type:

Wear appropriate gloves.

Respiratory / Type: None required under normal use.

Eye / Type:

Safety glasses recommended.

Footwear / Type: Safety shoes per local regulations.

Clothing / Type: As required to prevent skin contact.

Other / Type: Eye wash facility should be in close proximity.
Emergency shower should be in close proximity.

Ventilation requirements: Local exhaust at points of emission.

Atlantic Methanol Production Company LLC
Ugland House, P.O. Box 309
Georgetown, Grand Cayman
Cayman Islands, British West Indies

Methanol

Material Safety Data Sheet, 9 Pages

Revised January 4, 2012

1. CHEMICAL PRODUCT and EMERGENCY TELEPHONE CONTACT

Product Name……………………………………………….: Methanol
Chemical Family…………………………………………….: Aliphatic Alcohol
Synonyms……………………………………………………: Carbinol, Columbian Spirits, Methyl Alcohol, Pyrolygneous Spirits, Wood Alcohol, Methylol, Wood Naptha, Wood Spirits, Manhattan Spirits, Pyroxylic Spirits, Colonial Spirits, Methyl Hydroxide, Monohydroxymethane
Formula………………………………………………………: CH_3OH

EMERGENCY TELEPHONE NUMBERS
CHEMTREC, United States, Canada, Puerto Rico, Virgin Islands: 1-800-424-9300
CHEMTREC, International And Ships at Sea, emergency collect calls are accepted: 001-703-527-3887
Emergency Contact for Malabo, Equatorial Guinea, West Africa :
Call AMPCO at +240-222-245-367 (mobile) +1-713-328-1340 (land line via USA)

2. COMPOSITION/INFORMATION ON INGREDIENTS

Ingredient Name/CAS Number	Concentration	Exposure Limits
Methanol/# 67-56-1	99-100%	200 ppm TWA
		250 ppm STEL
		6,500 ppm IDLH
		1 ppm = 1.33 mg/m

3. HAZARDOUS IDENTIFICATION

EMERGENCY OVERVIEW

Methanol is a colorless volatile liquid with a faintly sweet pungent odor or similar to ethyl alcohol. The substance is fully soluble in water. Vapors of methanol are slightly heavier than air and may travel some distance to a source of ignition and flash back. Accumulations of vapors in confined spaces such as buildings or sewers may explode if ignited. There is potential for containers of liquid to rupture violently if exposed to fire or excessive heat for sufficient time duration. Methanol is listed as a "Poison-Class B". It is harmful if swallowed or absorbed through the skin. Ingestion of as little as one ounce can cause irreversible injury to the nervous system, blindness, or death. It cannot be made non-poisonous. Causes eye and respiratory system irritation and may cause skin irritation. Avoid liquid, mist or vapor contact. Vapor inhalation or liquid penetration of the skin can cause central nervous system depression.

POTENTIAL HEALTH EFFECTS

Primary Route of Entry: Inhalation, skin contact/absorption, eye contact, and ingestion.
General Acute Exposure: Liquid, mist, or vapor can cause eye, skin, and respiratory tract irritation and Central Nervous System (CNS) depression.

Inhalation
Acute Exposure: Short term exposure to high concentrations of methanol may cause CNS depression. Symptoms may include headache, weakness, drowsiness, lightheadedness, nausea, difficult breathing, drunkenness, eye irritation, blurred vision, blindness, loss of consciousness, vertigo, fatigue, convulsions, and possibly death, depending on exposure. Victims may improve and then get worse again up to 30 hours later.

Skin
Acute Contact: Upon prolonged or repeated contact, absorption through the skin may occur and produce toxic effects similar to those resulting from inhalation exposure. Repeated or prolonged skin contact may cause drying, cracking, and inflammation of the skin due to the defatting action of the product.

Eye
Acute Contact: Eye irritation may occur upon short term exposure, including a burning sensation, tearing, redness, or swelling. Upon direct contact with liquid, conjunctivitis and corneal burns may occur. Methanol's main toxic effect is exerted upon the nervous system, particularly the optic nerves and possibly the retina. The condition can progress to permanent blindness.

Ingestion
Ingestion may cause serious poisoning with effects similar to those of inhalation and absorption through the skin. Toxic effects are more common after ingestion. Death from as little as 1.0 ounce has been reported.

Neurologic
Acute Exposure: CNS depression may occur upon exposure.

Summary of Chronic Exposure
Methanol may slowly eliminate from the body, hence repeated exposure may result in toxic levels in the blood and tissues. Due to its slow elimination, methanol should be regarded as a cumulative poison. Though single exposures to fumes may cause no harmful effect, daily exposure may result in the accumulation of sufficient methanol in the body to cause illness.

Note to the Physician: Coma resulting from massive exposure may last as long as 2-4 days. In the body, products that may be formed by its oxidation are formaldehyde and formic acid.

Carcinogenicity:
NTP………………………………………………….: Not Listed
IARC…………………………………………………..: Not Listed
OSHA……………………………………………….: Not Listed

Medical Conditions Aggravated by Exposure: Personnel with pre-existing CNS disease, skin disorders, impaired liver or kidney function, GI tract disorders or chronic respiratory disease should avoid exposure.

4. FIRST AID MEASURES

First Aid for Eyes: Immediately flush eyes with copious amounts of tepid water for at least 15 minutes. The patient should be seen in a health care facility and referral to an ophthalmologist should be considered.

First Aid for Skin: Immediately flush eyes with copious amounts of tepid water for at least 15 minutes while removing contaminated clothing and shoes, followed by washing area thoroughly with soap and water. The patient should be seen in a health care facility if irritation or pain persists or if symptoms of toxicity develop. Wash contaminated clothing and shoes before reuse.

First Aid for Inhalation: Move patient to fresh air and keep warm and at rest. Monitor for respiratory distress. If difficulty in breathing develops or if breathing has stopped, administer artificial respiration and seek medical attention. If trained to do so, administer supplemental oxygen with assisted ventilation as required. *Caution:* Administration of mouth-to-mouth resuscitation may expose the first aid provider to chemical within the victim's lungs or vomit.

First Aid for Ingestion: If patient is conscious, immediately give two glasses of water and induce vomiting. Do not make unconscious person vomit. Get immediate medical attention. **NOTE:** NIOSH suggests that vomiting be induced only if immediate medical attention is not available.

Note to Physicians: Provide standard methanol ingestion treatment. To prepare antidote, make a solution using 100 ml 0f 100-proof ethyl alcohol (grain alcohol) in 200 ml of water and give 1.5 ml per kg of body weight, or 100 ml for an average adult. Following this, at 2-hour intervals for 4 days, give antidote (0.5-1.0 ml per kg of body weight, orally or intravenously to reduce metabolism of the methanol and to allow time for its excretion). Blood ethanol levels should be 1.0-1.5 mg/ml.

5. FIRE FIGHTING MEASURES

Flash Point……………………………………………………..: 52°F (11°C), closed cup
Lower Flammable Limit…………………………………..: 6.0% Volume in Air
Upper Flammable Limit…………………………………..: 36.5% Volume in Air
Auto Ignition Temperature…………………………...: 725°F, 385°C

General Information:
Methanol is extremely flammable. This material releases vapors at or below ambient temperatures. When mixed with air this substance can burn in the open or explode in confined space conditions. Methanol vapors are heavier than air and may travel long distances along the ground before reaching a point of ignition and flashing back. Methanol-water mixtures containing as little as 21% methanol by volume (25% by weight) are also flammable liquids. Methanol fires may not be visible to the naked eye during daylight.

Extinguishing Media:

Water may be ineffective but may be used to dilute spills to non flammable mixtures.

Small Fire……………………………..: Dry Chemical, CO2, Water spray or alcohol-resistant foam

Large Fire……………………………..: Water Spray, fog or alcohol-resistant foam

Special Fire Fighting Procedures:

a. Move container from fire area if you can do it without risk.
b. Apply cooling water to sides of containers that are exposed to flames until well after fire is out. Stay away from ends of tanks due to exploding potential when tanks are involved in a fire.
c. Dike fire control water for later disposal, do not scatter the material.
d. Do not use straight streams due to spreading of methanol.
e. Positive pressure self-contained breathing apparatus (SCBA) should be used when there is a potential for inhalation of vapors and/or fumes.
f. Structural fire fighter's protective clothing is recommended for fire situations ONLY; it is not effective in spill situations.

Fire Involving Tanks or Rail Car/Trailer Loads

a. Fight from maximum distance or use unmanned hose holders or monitor nozzles.
b. Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank.
c. For massive fire, use unmanned hose holders or monitor nozzles; if this is impossible, withdraw from the area and let fire burn.
d. Isolate area for ½ mile (0.8 km) in all directions.

6. <u>ACCIDENTAL RELEASE MEASURES</u>

Spill or Leak Measures: Stop leak if you can do it without risk. Keep unnecessary people away and deny entry. Isolate spill or leak area immediately for at least 330 to 660 feet (100 to 200 meters) in all directions. Stay upwind, out of low areas, and ventilate closed spaces before entering. Eliminate all ignition sources. Do not touch or walk through spilled material. Prevent entry of product to waterways, sewers, basements, or confined spaces. A vapor suppressing foam may be used to reduce vapors. All equipment used when handling the product must be grounded and/or spark resistant. Water spray may reduce vapors, but may not prevent ignition in closed spaces. Fully encapsulating, vapor protective clothing with flash protection should be worn for spills and leaks with no fire.

Determining Spill Size: Generally, a small spill is one which involves a single, small package (i.e. up to 55 gallon drum, 200 liters), small cylinder, or a small (non-continuing) leak from a large container.

Small Spill:

a. Absorb with earth, sand or non-combustible material and transfer to containers for later disposal.
b. Use clean non-sparking tools to collect absorbed material.

Large Spill:

a. Dike far ahead of liquid spill for later disposal.
b. Follow local protocol for handling.
c. Water spray may reduce vapor, but may not prevent ignition in closed spaces.

7. HANDLING AND STORAGE

Handling and storage for methanol should follow the standard listed below. Other standards or regulations may apply which are not listed.

a. National Electrical Code; Hazard Classification for Methanol is Class 1, Div. 1 or 2, Group D.
b. NFPA No. 30, "Flammable and Combustible Liquids Code"

Handling Precautions: Use proper personal protective equipment when working with or around methanol. No smoking or open flame in storage, use, or handling areas. Use explosion-proof electrical equipment. Ensure proper electrical grounding procedures are in place. See Section 8.

Storage: Store in totally enclosed equipment, designed to avoid ignition and human contact. Tanks must be grounded, vented, and should have vapor emission controls. Tanks must be diked as per NFPA or API Standards. A flammable mixture of methanol vapor and air is possible inside a storage tank or transportation tank, and handlers should take appropriate precautions to reduce the risk of ignition. Handlers must eliminate ignition sources or purge the tank with an inert gas such as nitrogen. All equipment must be grounded – bonded when transferring product in order to avoid static discharge from the equipment, and subsequent possible fire. Avoid storage with incompatible materials. Anhydrous methanol is non-corrosive to most metals at ambient temperatures except for lead, nickel, monel, cast iron, and high silicon iron. Coatings of copper (or copper alloys), zinc (including galvanized steel), or aluminum are unsuitable for storage. These materials may be attacked slowly by the methanol. Storage tanks of welded construction are normally satisfactory. They should be designed and built in conformance with good engineering practice for the material being stored. While plastics can be used for short term storage, they are generally not recommended for long-term storage due to deterioration effects and the subsequent risk of contamination.

8. EXPOSURE CONTROLS, PERSONAL PROTECTION

Respiratory Protection Requirements

Less than 200 ppm………:	No protection required if TWA is not exceeded.
200 to 250 ppm……………:	Protection required if the daily TWA is exceeded, fresh air supplied system must be used if protection is needed.
Greater than 200 ppm…:	A fresh air supply system must be used if protection is needed (i.e., positive pressure self contained breathing apparatus).

Skin Protection Requirements: Equipment should prevent repeated or prolonged skin contact with the product. This may include rubber boots, resistant gloves, and other impervious and resistant clothing. Compatible materials may include butyl rubber, natural rubber, neoprene, nitrile rubber, viton and others. Review the manufacturer's compatibility data.

Eye Protection Requirements: Use chemical (indirectly vented) goggles when there is a potential for contact with product. including vapor. A full-face shield may be worn over goggles for additional protection, but not as substitute for goggles.

Other Protective Equipment: Safety shower and eyewash fountain should be provided in the methanol handling area.

Engineering Controls: Adequate ventilation to keep methanol concentrations below applicable standards when possible.

NOTE: See Section 2 regulatory exposure guidelines.

9. PHYSICAL AND CHEMICAL PROPERTIES

Physical Form……………………………………………………..: Liquid
Color…………………………………………………………………..: Colorless
Odor…………………………………………………………………..: Faintly sweet pungent odor like ethyl alcohol
Boiling Point……………………………………………………….: 148° F (64° C) at atmospheric pressure
Melting Point………………………………………………………: -144° F (-98° C)
pH……………………………………………………………………….: 7.2
Solubility…………………………………………………………….: 100%
Specific Gravity…………………………………………………..: 0.792 @ 68° F (20° C)
Vapor Density……………………………………………………..: 1.11 @ 60° F, (15.6° C)
Vapor Pressure…………………………………………………..: 1.86 psia @ 68° F (20° C)
% Volatile by Volume…………………………………………. : 100
Molecular Weight……………………………………………….: 32.04
Density………………………………………………………………: 6.63 lb. per gallon @ 60° F
0.7945 kg per liter @ 15.6° C
Critical Temperature…………………………………………..: 464° F (240° C)
Critical Pressure………………………………………………….: 1,142 psia (77.77 bar)

10. REACTIVITY

Stability…………………………………………………………………: This is a stable material
Hazardous Polymerization……………………………………: Will not occur

Decomposition:
Excessive heating and/or incomplete combustion will generate carbon monoxide, formaldehyde, and possible unburned methanol.

Incompatibilities:

a. Methanol has an explosive reaction with chloroform + sodium methoxide and diethyl zinc (see following note).
b. Methanol has a violent reaction with alkyl aluminum salts, acetyl bromide, chloroform + sodium hydroxide, cyanuric chloride, nitric acid, etc. (see following note).
c. Incompatible with beryllium dihydride, metals (potassium, magnesium, etc.), oxidants (barium, perchlorate, bromine, chlorine, etc.), etc. (see following note).
d. Dangerous; can react vigorously with oxidizing materials (see following note).

NOTE: The incompatibilities above are a partial list taken from two books by Sax & Lewis: "Dangerous Properties of Industrial Materials", 9th ed., 1995 and "Hawley's Condensed Chemical Dictionary", 11th ed. 1987, both published by Van Nostrand Reinhold Company, New York. It is recommended that if information is needed, refer to these and other published sources.

11. TOXICOLOGICAL INFORMATION

LDL0 Human……………………………: 143 mg/kg; Eye, Pul, GIT
LD50 Mouse……………………………: 7300 mg/kg
LC50 Rat…………………………………: 64,000 ppm/4H
LC50 Goldfish…………………………: 250 ppm/11H

Carcinogenicity: Not listed by IARC, NTP, ACGIH, or OSHA as carcinogen.

Teratogenicity: Methanol has produced fetotoxicity in rats and teratogenicity in mice exposed by inhalation to high concentration of methanol vapors.

Reproductive Toxicity: Information available does not suggest that methanol is a reproductive toxin.

Mutagenicity: There is insufficient information available to conclude that methanol is mutagenic.

Synergistic Products: In animals, high concentration of methanol can increase the toxicity of other chemicals, particularly liver toxins like carbon tetrachloride. Ethanol significantly reduces the toxicity of methanol because it completes for the same metabolic enzymes, and has been used to treat methanol poisoning.

Potential for Accumulation: Methanol is readily absorbed in the body following inhalation and ingestion. Skin absorption may occur if the skin is broken or exposure is prolonged. Once absorbed, methanol is rapidly distributed to the body tissues. A small amount is excreted unchanged in exhaled air and urine. The rest is first metabolized to formaldehyde, which is then metabolized to formic acid and/or formate. The formic acid and formate are converted into carbon dioxide and water. In humans, methanol clears from the body, after inhalation or oral exposure, with a half-life of 1 day or more for high doses (greater than 1000 mg/kg) or about 1.5 to 3 hours for low doses (less than 100 mg/kg or 76.5 to 230 ppm (100-300 mg/m^3)).

Medical Condition Aggravated By Exposure: Persons with pre-existing skin disorders, eye problems, respiratory conditions, or impaired liver or kidney functions may be more susceptible to the effects of this substance.

12. ECOLOGICAL INFORMATION

a. Methanol is harmful to aquatic life in low concentrations and may be hazardous if it enters water intakes.
b. Local health and wildlife authorities, as well as operators of water intakes in the vicinity, should be notified of water releases.
c. Biological Oxygen Demand: 0.6 to 1.2 lb/lb in 5 days.

13. **DISPOSAL CONSIDERATIONS**

Waste must de disposed of in accordance with federal, state, and local environmental control regulations. Waste methanol in concentrations equal to or greater than 24%, by weight, meets the definition of an ignitable hazardous waste. Product grade methanol, when disposed, is listed as hazardous waste.

For large spills, maximize product recovery for reuse or recycling. Free liquid may be collected using explosion-proof pumps. For small spills, take up with sand or non-combustible absorbent. Use registered transporters to move contaminated product/soil/water in D.O.T. approved containers. Dispose of materials at a licensed facility permitted to handle RCRA/OSHA "Hazardous Wastes". Incineration is the recommended disposal method. Burn concentrated liquid in systems compatible with water soluble waste. Biodegradation may be used on dilute aqueous waste. Assure emissions and effluent comply with applicable laws.

14. **TRANSPORTATION INFORMATION**

Regulation

ID Number	Proper Shipping Name	Hazard Class	Subsidiary Hazards	Packing Group	Marine Pollutant/ltd. qty
U.S. DOT - Road					
UN 1230	Methanol	3	6.1	II	
U.S. DOT - Rail					
UN 1230	Methanol	3	6.1	II	
U.S. DOT – Inland Waterways					
UN 1230	Methanol	3	6.1	II	
Transport Canada – Road					
UN 1230	Methanol	3	6.1	II	
Transport Canada – Rail					
UN 1230	Methanol	3	6.1	II	
Transport Canada – Inland Waterways					
UN 1230	Methanol	3	6.1	II	
International Maritime Dangerous Goods					
UN 1230	Methanol	3	6.1	II	
International Air Transport Association – Cargo					
UN 1230	Methanol	3	6.1	II	
International Air Transport Association - Passenger					
UN 1230	Methanol	3	6.1	II	
Mexican Regulation for the Land Transport of Hazardous Materials and Wastes					
UN 1230	Methanol	3	6.1	II	

D.O.T. Placard……………………………………………….: Flammable Liquid. Class 3, color: red
OSHA Label Required…………………………………: Yes
RQ (Reportable Quantity)……………………………: 5000 pounds or approx. 755 gallons
STCC Number…………………………………………………: 49 092 30

15. REGULATORY INFORMATION

OSHA: This product is considered hazardous material under criteria of the Federal OSHA Hazard Communication Standard 29 CFR 1910.1200.

SARA TITLE III:

a. EHS (Extremely Hazardous Substances) List : Not Listed
b. Note: Chemicals on the original list that do not meet the toxicity criteria, but, because of their high production volume and recognized toxicity, are considered chemicals of concern (“other chemicals”).
c. RQ (Reportable Quantity): Not Listed
d. TPQ (Threshold Planning Quantity): Not Listed
e. Section 313: “Specific Toxic Chemical Listings” – 40 CFR Part 372
f. Methanol is subject to the reporting requirements of Section 313 and 40 CFR Part 372. 40 372.45 requires Atlantic Methanol Production Company LLC to notify certain customers as to which of its mixtures or trade name products contains those chemicals. The purpose of that notification is to ensure that facilities that may be subject to reporting requirements of Section 313 and that use products of unknown formulation will have knowledge that they are receiving products that contain chemicals subject to those reporting requirements.

CERCLA Hazardous Substance List:

a. RQ (Reportable Quantity): 5,000 pounds or approximately 755 gallons
b. Regulation: “Designation, Reportable Quantities, Notification” – 40 CFR 302

TSCA Inventory: Listed (RTECS)

	HMIS	NFPA
Health	1*	1
Flammability	3	3
Physical Hazards	0	
Instability		0
Specific Hazard	--	--

16. OTHER INFORMATION

The information and recommendations herein are taken from data contained in independent, industry-recognized references we believe to be reliable including, but not limited to, NIOSH, OSHA, NFPA, D.O.T. ERG, CHRIS, and SAX’s Dangerous Properties of Industrial Materials. Thus Atlantic Methanol Production Company LLC makes no guarantee, warranty or other representation concerning the information provided above. Users should make their own investigation to determine the suitability of the information for their particular purposes. The substance is intended for use only by persons having the necessary technical skills and facilities for handling the product at their discretion and risk. Proper care and use of the substance is beyond Atlantic Methanol Production Company LLC’s control and sole responsibility lies with the users of the substance. Atlantic Methanol Production Company LLC disclaims any liability for loss or damage incurred in connection with the use of this substance.

MILTON INDUSTRIES, INC.

PH. 773.235.9400
FAX. 773.235.3221
4500 WEST CORTLAND STREET CHICAGO. ILLINOIS 60639 www.miltonindustries.com

MSDS SHEET FOR DESSICANT BEADS

1. PRODUCT IDENTIFICATION

Name:	Blue Silica Gel
Synonyms:	Silica, amorphous; Silica, precipitated and gel (CAS # 112926-00-8) (OSHA)
CAS No:	Not applicable
Molecular Weight:	Not applicable
Chemical Formula:	Si02, XH20 + CoCI2
Product Codes:	See detail drawing

2. COMPOSITION/INFORMATION on INGREDIENTS

Ingredient	CAS NO	Percent	Hazardous	R Phrases
Silica Gel	63231-67-4	> 99.7%	Yes	
Cobalt Chloride	7646-79-9	< 0.3%	Yes	R22,R36,R42/43

3. HAZARDS IDENTIFICATION

Emergency Overview
Toxic (See hazard warning label)
Safety Data Ratings (Provided here for your convenience)

Health rating: Moderate
Flammability Rating: None
Reactivity Rating: None
Contact Rating: Slight
Lab Protective Equip: Goggles, lab coat, vent hood, proper gloves
Storage Color Code: Orange (General Storage)

Potential Health Effects: This product contains synthetic amorphous silica: not to be confused with crystalline silica such as quartz, cristobalite or tridymite or with diatomaceous earth or other naturally occurring forms of amorphous silica that frequently contain crystalline forms.

Inhalation: May cause dryness and irritation to mucous membranes, nose, and throat.

Symptoms:

May include coughing, sore throat and wheezing.
Ingestion: No adverse effects expected
Skin Contact: May cause irritation with dryness and abrasion.
Eye Contact: May cause irritation, redness and pain.
Chronic Exposure: Repeated exposure may cause symptoms similar to those listed for acute effects.
Synthetic amorphous silica does not produce silicosis> Prolonged exposure to cobalt has been shown to cause cancer in laboratory animals.
Aggravation of Pre-existing Conditions: No information found.

PH. 773.235.9400
FAX. 773.235.3221
4500 WEST CORTLAND STREET CHICAGO. ILLINOIS 60639 www.miltonindustries.com

4. FIRST AID MEASURES

Inhalation: Move to fresh air. Get immediate medical attention for any breathing problems.

Ingestion: Drink several glasses of water to dilute. If large amounts were swallowed seek immediate medical attention.

Skin Contact: Immediately flush skin with soap and water for at least 15 minutes. Remove contaminated clothes and shoes. Wash clothing before reusing. Thoroughly clean shoes before reusing. Seek immediate medical attention of irritation develops.

Eye Contact: Immediately flush eyes with plenty of water for at least 15 minutes, lifting upper and lower eye lids occasionally. Seek immediate medical attention if irritation persists.

5. FIRE FIGHTING MEASURES

Fire: Not considered to be a fire hazard.

Explosion: Not considered to be an explosion hazard.

Fire Extinguishing Media: Use any means suitable for extinguishing surrounding fire.

Special information: Use protective clothing and breathing equipment appropriate for the surrounding fire.

6. ACCIDENTAL RELEASE MEASURES

Ventilate area of leak or spill. Wear appropriate personal protective equipment as specified in Section 8. Spills: Sweep up and containerize for reclamation or disposal. Vacuuming or wet sweeping may be used to avoid dust dispersal. Regulations require reporting spills and releases to soil, water and air in excess of reportable quantities.

7. HANDLING AND STORAGE

Keep in a tightly closed container, stored in a cool, dry, ventilated area and labeled accordingly. Protect against physical damage. When pouring into a container of flammable liquid, ground both containers electrically to prevent a static electric spark. Containers of this material may be hazardous when empty since they retain product residues (dust, solids); observe all warnings and precautions listed for the product.

8. EXPOSURE CONTROL/PERSONAL PROTECTION

Airborne Exposure Limits:

Silica (synthetic, amorphous):

- OSHA Permissible Exposure Limit (PEL)
- 80/ (%Si02) mg/m³ (TWA) for amorphous silica, including natural diatomaceous earth.
- ACGIH Threshold Limit Value (TLV) - 10 mg/m³ (TWA) fore amorphous precipitated silica and amorphous silica gel.

For Inorganic Cobalt Compounds:

- ACGIH Threshold Limit Value (TLV) – 0.02 mg/m³ (TWA) as Co, A3: Animal carcinogen.

Ventilation Systems: A system of local and /or general exhaust is recommended to keep employee exposures below the Airborne Exposure Limits. Local exhaust ventilation is generally preferred because it can control the emissions of the contaminant at its source, preventing dispersion of it into the general work area. Please refer to the ACGIH document, Industrial ventilation. A manual of Recommended practices, most recent edition, for details.

Personal Respirators: If the exposure limit is exceeded, a half –face dust/mist respirator must be worn suitable for the exposure limit or the maximum use concentration specified by the appropriate regulatory agency or respirator supplier, whichever is lowest.
Warning: Air-purifying respirators do not protect workers in oxygen-deficient atmospheres. Respirators must meet the requirements of European Standard EN149 FF3SL. Suitable for use under COSHH, CAW, CLAW and IRR.
Skin Protection: Wear protective gloves and clean body-covering clothing.
Eye Protection: Use chemical safety goggles. Maintain eye wash fountain.

9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance: Blue crystals.
Odor: Odorless
Solubility: Silica gel base is insoluble in water: cobalt chloride may leach out.
Specific Gravity: 2.1
PH: 5.5-9.0 (in 5% slurry) %
Volatiles by volume @ 21° C (70° F): 0
Boiling Point: No information found
Melting Point: No information found
Vapor density: (Air=1): No information found
Vapor pressure: (mm Hg): No information found
Evaporation Rate (BuAc=1): No information found

10. STABILITY AND REACTIVITY

Stability: Stable under ordinary conditions of use and storage.
Hazardous Decomposition Products: Oxides of carbon and silicone may be formed when heated to decomposition.
Hazardous Polymerization: Will not occur.
Incompatibility: Reacts with hydrogen fluoride, fluorine, oxygen difluoride, chlorine trifluoride, strong acids, strong bases and oxidizers.
Conditions to avoid: Moisture, extreme heat and incompatibles.

11. TOXICOLOGICAL INFORMATION

Toxicological Data: no LD50/LC50 information found relating to normal routes of occupational exposure.
Carcinogenicity: Cobalt and its compounds have been shown to cause cancer in laboratory animals.

12. ECOLOGICAL INFORMATION

Environmental Fate: For Silica Gel (synthetic amorphous): When released into the soil, the material is not expected to biodegrade. When released into water, this material is not expected to biodegrade.
Environmental Toxicity: For Silica Gel (synthetic amorphous): This material is not expected to be toxic to aquatic life.

PH. 773.235.9400
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4500 WEST CORTLAND STREET CHICAGO. ILLINOIS 60639 www.miltonindustries.com

13. DISPOSAL CONSIDERATIONS

Whatever cannot be saved for recovery or recycling should be managed in an appropriate and approved waste disposal facility. Processing, use or contamination of this product may change the waste management options. Local disposal regulation may differ from national disposal regulations.

14. TRANSPORT INFORMATION

Not regulated.

15. REGULATORY INFORMATION

---------------------------\ Chemical Inventory Status- Part 1 \---

Ingredient	EC
Silica Gel (63231-64-4)	NO
Cobalt (II) Chloride (7646-79-9)	NO

--------------------------\Federal, State & International Regulations – Part 1 \--------------------------

	--SARA 302--		----SARA 313 -----	
Ingredient Catg.	RQ	TPQ	List	Chemical
Silica Gel (63231-67-4)	No	No	No	No
Cobalt (II) Chloride (7646-79-9)	No	No	No	Cobalt compound

--------------------------\Federal, State & International Regulations – Part 2 \--------------------------

		--RCRA--	--TSCA—
Ingredient	CERCLA	261.33	8 (d)
Silica Gel (63231-67-4)	No	No	No
Cobalt (II) Chloride (7646-79-9)	1	No	No

Poison Schedule: No information found

This MSDS has been prepared according to the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all of the information required by the CPR.

EC Classification: Carcinogenic

R Phrases: R 49 May cause cancer by inhalation R42/43 may cause sensitization by inhalation and skin contact.

S Phrases:
S22-Do not breathe dust.
S53-Avoid exposure – obtain special instructions before use.
S45-In case of accident or if you feel unwell, seek medical attention.
S60- This material and /or its container must be dispose of as hazardous waste.
S2- Keep out of reach of children.

EINECS Listing: Preparation – all components listed

16. OTHER INFORMATION

Label Hazard Warning: Toxic

Label Precautions:

Avoid contact with eyes, skin and clothing
Avoid breathing dust.
Keep container closed.
Use with adequate ventilation.
Wash thoroughly after handling.

Label First Aid: If inhaled, move to fresh air. Get medical attention of any breathing difficulty. In case of contact, immediately flush eyes or shin with plenty of water for at least 15 minutes. Get medical attention if irritation develops or persists.

Product use: Transformer Breathers, Tank Vent Dryers, Drum Vent Dryers, Air Drying Applications and Laboratory Reagent.

MATERIAL SAFETY DATA SHEET - BORESAVER ULTRA C AUS

SECTION 1 – IDENTIFICATION & USE

TRADE NAMES :	**BORESAVER ULTRA C**
CHEMICAL NAME:	Ethanedioic Acid Dihydrate
U.N. NO. :	UN 3261
TECHNICAL NAME :	Slightly Corrosive Solid, Organic Acid N.O.S Ethanedioic Acid Dihydrate (Oxalic acid)
DG CLASS :	8
PACKAGING GP. :	III
HAZCHEM :	2X
POISON SCHEDULE :	Schedule 6
APPLICATION & USES :	Cleaning compounds-rust removal; leather tanning. A cleaning agent to remove iron oxide from water bores, pumps, reticulation systems and other industrial water systems.
EMS	F-A, S-B

MANUFACTURER

Aquabiotics Industrial Pty Ltd
14 Goongarrie Street, Bayswater, Western Australia 6053
Tel: 0061 (0)8 9379 2911 Fax: 0061 (0)8 676856

SECTION 2 – COMPOSITION & INGREDIENTS

CHEMICAL COMPOSITION

Ethanedioic Acid Dihydrate	144-62-7	>90%
N.O.S	n/a	>8%

A pale blue unconsolidated crystalline solid mixture. Non-flammable, non-volatile. Solubility in water is approximately 100 g/L. odorless

CLASSIFICATION Slightly Corrosive Solid (III)

SECTION 3 – IDENTIFICATION OF HAZARD & RISK

CLASSIFICATION	Corrosive. Harmful in Concentrated State
RISK PHRASES	**R21/22:** Harmful in contact with skin and if swallowed.
SAFETY / HAZARD PHRASES	**S2:** Keep out of reach of children. **S24/25:** Avoid contact with skin and eyes.
OTHER	Combustible solid. On burning will emit toxic or noxious fumes (carbon monoxide & carbon dioxide). Can react spontaneously with sodium hypochlorite.

SECTION 4 – FIRST AID MEASURES

HEALTH EFFECTS
ACUTE EFFECTS

SWALLOWED:	Corrosive. Swallowing may cause severe burns of mouth, throat and stomach. Symptoms may include vomiting, abdominal pain, collapse and possible convulsions.
EYE:	Corrosive to eyes. Contamination of eyes can result in permanent injury.
SKIN:	Contact with skin may cause irritation and prolonged contact may cause corrosive injury.
INHALED:	No Dust Hazard
CHRONIC EFFECTS	No information available.

FIRST AID

SWALLOWED:	IF conscious, immediately rinse mouth with water & give water to drink. DO NOT induce vomiting. Seek immediate medical assistance. Do not give liquids to an unconscious person.
EYE:	Immediately irrigate with copious quantities of water for at least 15 minutes. Eyelids to be held open while washing. If pain persists seek immediate medical assistance.
SKIN:	Remove contaminated clothing. Wash affected area with large amount of water. If irritation develops seek immediate medical assistance.
INHALED:	Remove victim from exposure. Remove contaminated clothing and loosen remaining clothing. Allow patient to assume most comfortable position and keep warm. Keep at rest until fully recovered. If breathing labored ensure airways are clear and administer oxygen. If breathing has stopped apply artificial respiration at once. Seek immediate medical assistance.
ADVICE TO DOCTOR	Treat symptomatically

SECTION 5 – FIRE MEASURES

GENERAL:	Decomposes on rapid heating at ca. 150 C, which will emit toxic or noxious fumes of carbon dioxide and carbon monoxide. Can react spontaneously with sodium hypochlorite
EXTINGUISHERS:	Use extinguishing media appropriate for surrounding fire. Water spray, foam, carbon dioxide or dry chemical powder.
FIRE FIGHTERS:	Fire fighters to wear self contained breathing apparatus and full protective clothing when fighting fire
GENERAL:	Move products out of fire area if safe to do so. Cool containers if feasible. Stay upwind of fumes, keep out of low areas.

SECTION 6 – SPILLS MEASURES

Wear proper protective equipment to prevent skin and eye contact.
Cover with damp absorbent (sand, soil or inert material). Sweep up. With a clean shovel, transfer spilled material into clean-labeled containers for disposal.

Prevent large quantities from entering drains, sewers, streams or other bodies of water. If contamination of sewers or waterways has occurred, advise the local emergency services.
Dispose in accordance with federal, state or local regulations.

SECTION 8– PERSONEL PROTECTION & EXPOSURE LIMITS

LONG TERM EXPOSURE LIMITS: Skin Irritation **TWA:** 1 mg/m^3 averaged over an 8-hour work shift. Skin Irritation **STEL:** 2 mg/m^3, not to be exceeded during any 15-minute work period.
(Product is manufactured such that no dust hazard exists)
As published by the National Occupational Health and Safety Commission (Worksafe Australia).

EXPOSURE CONTROL: Avoid skin and eye contact.
Body Protection: Overalls & Safety Boots to EN 369
Eye Protection: Safety Glasses or goggles to EN 166
Hand Protection: Chemical resistant gloves to EN374-1 (Chemical), EN388 (Mechanical), EN420 (Marking)

Always wash hands before smoking, eating, drinking or using the toilet.

MANUFACTURING CONTROLS Avoid generating and inhaling dusts.

SECTION 9 – PHYSICAL PROPERTIES

APPEARANCE:	A pale blue unconsolidated crystalline solid mixture. Non-flammable, non-volatile. Solubility in water is approximately 100 g/L. odorless.
MELTING POINT:	187°C
BOILING POINTS:	149 to 160°C (for the di-hydrate)
VAPOUR PRESSURE (20°C):	< 0.14 Pa
SPECIFIC GRAVITY (25°C):	1.65
FLASH POINT (OPEN CUP):	No data available
EXPLOSION LIMITS:	No data available
SOLUBILITY IN WATER:	Soluble in water
AUTOIGNITION TEMP:	No data available
VAPOUR DENSITY:	No data available
pH:	2 approx. in its concentrated form
STORAGE COLOUR CODE:	White (Corrosive)

SECTION 10 – STABILITY & REACTIVITY

STABILITY: Decomposes on rapid heating at ca. 150 C
REACTIVITY: Vigorous reaction may occur with alkalis. May react violently with alkali metals producing flammable hydrogen gas. Reacts strongly with oxidizing agents.
Can react spontaneously with sodium hypochlorite.

SECTION 11 – TOXICOLOGICAL INFORMATION

TOXICOLOGICAL TESTING: Oral LD50 (rat): 375 mg/kg
Exposure to this compound can result in systemic effects including kidney damage, muscle twitching, cramps and central nervous system effects.

SECTION 12 – ECOLOGICAL INFORMATION

ECOTOXICITY: Avoid contaminating waterways in raw or concentrated state.

BIOACCUMULATION: No data available
GENERAL: No ecological problems are expected when the product is handled and used with due care

SECTION 13 – DISPOSAL

Mix with weak alkaline solution and dispose of in accordance with Federal, State or Local regulations.

SECTION 14 – TRANSPORT

With reference to the UNECE Committee of Experts on the Transport of Dangerous Goods, The European Agreement concerning the International Carriage of Dangerous Goods by Road.
Annex A: Part 3 Dangerous goods list, special provisions and exemptions related to dangerous goods packed in limited quantities

LIMITED QUANTITIES: Gross Weight ≤ 5kg Under section 3.4.6 code LQ24 applies and states that if the maximum package gross weight is 5kg or below, then this product is not classified as a dangerous good for road or rail transport within the EEC.

PACKING: Products are packed in plastic bags within sealed polyethylene press on lid pails (max. 20kg) or woven plastic or plastic film bags (max. 20kg)

SECTION 15 – REGULATORY INFORMATION

Approved as safe for use with Potable Water Supplies under regulation 31(4) of the Water Supply (Water Quality) reg 2000 No. 3184 & of the Water Supply (Water Quality) Regulations 2001 (Wales) No. 3911 if used in conjunction with Product Application Manual Issue 180104 v6.4 17/1/04.

Tested and Certified by NSF International NSF/ANSI Standard #60

SECTION 16 – OTHER INFORMATION

The information contained herein is based on the present state of knowledge. It characterizes the product with regard to the appropriate safety precautions.

OAKTON® MATERIAL SAFETY DATA SHEET

Section 1. Chemical Product and Company Identification

Catalog Number(s)

00654-00, 05942-21, 05942-22, 05942-24, 05942-25, 05942-26, 05942-27, 35653-01, 35654-00

Product Identity

BUFFER, Standard, pH 4.01; BUFFER, High Accuracy, pH 4.000 (Color Coded Red)

Manufacturer's Name	Emergency Telephone Number (24 hr)
RICCA CHEMICAL COMPANY	CHEMTREC®: 800-424-9300
Address (Number, Street, City, State, and ZIP Code)	Telephone Number For Information
P.O. Box 13090	817-461-5601
	Date Prepared
Arlington, Texas 76094	3-7-2000

Section 2. Composition / Information on Ingredients

Component	CAS Registry #	Percent Concentration	Exposure Limits ACGIH TLV	OSHA PEL
Potassium Acid Phthalate	877-24-7	0.95 – 1.05	N/A	N/A
Preservative* *(No Mercury compounds or Formaldehyde)	proprietary	<0.5	N/A	N/A
Inert Dye	proprietary	<0.1	N/A	N/A
Water, Deionized	7732-18-5	Balance	N/A	N/A

Section 3. Hazards Identification

☆☆

EMERGENCY OVERVIEW

Non-flammable, non-toxic, non-corrosive. Does not present any significant health hazards. Wash areas of contact with water.

☆☆

POTENTIAL HEALTH EFFECTS:

TARGET ORGANS: eyes, skin.

EYE CONTACT: May cause slight irritation.

INHALATION: Not likely to be hazardous by inhalation.

SKIN CONTACT: May cause slight irritation.

INGESTION: Large doses may cause nausea, vomiting, diarrhea and cramps.

CHRONIC EFFECTS / CARCINOGENICITY:

IARC – No
NTP – No
OSHA – No

TERATOLOGY (BIRTH DEFECT) INFORMATION:

No information found in “Registry of Toxic Effects of Chemical Substances” or other information sources.

REPRODUCTION INFORMATION:

No information found in “Registry of Toxic Effects of Chemical Substances” or other information sources.

Section 4. First Aid Measures – In all cases, seek qualified evaluation.

EYE CONTACT: Irrigate immediately with large quantity of water for at least 15 minutes. Call a physician if irritation develops.

INHALATION: Remove to fresh air. Give artificial respiration if necessary. If breathing is difficult, give oxygen.

SKIN CONTACT: Flush with plenty of water for at least 15 minutes. Call a physician if irritation develops.

INGESTION: Dilute with water or milk. Call a physician if necessary.

Section 5. Fire Fighting Measures

FLAMMABLE PROPERTIES:

FLASH POINT: N/A METHOD USED: N/A

FLAMMABLE LIMITS

LFL: N/A UFL: N/A

EXTINGUISHING MEDIA: Use any means suitable for extinguishing surrounding fire.

FIRE & EXPLOSION HAZARDS: Not considered to be a fire or explosion hazard.

FIRE FIGHTING INSTRUCTIONS: Use normal procedures/instructions.

FIRE FIGHTING EQUIPMENT: Use protective clothing and breathing equipment appropriate for the surrounding fire.

Section 6. Accidental Release Measures

Absorb with suitable material and dispose of in accordance with local regulations.

Section 7. Handling and Storage

As with all chemicals, wash hands thoroughly after handling. Avoid contact with eyes and skin. Protect from freezing and physical damage. SAFETY STORAGE CODE: GENERAL

Section 8. Exposure Controls / Personal Protection

ENGINEERING CONTROLS: No specific controls are needed. Normal room ventilation is adequate.

RESPIRATORY PROTECTION: Normal room ventilation is adequate.

SKIN PROTECTION: Chemical resistant gloves.

EYE PROTECTION: Safety glasses or goggles.

Section 9. Physical and chemical Properties

APPEARANCE:	Clear, red colored liquid	**pH:**	4
ODOR:	odorless	**BOILING POINT (^{o}C):**	approximately 100
SOLUBILITY IN WATER:	infinite	**MELTING POINT (^{o}C):**	approximately 0
SPECIFIC GRAVITY:	approximately 1	**VAPOR PRESSURE:**	N/A

Section 10. Stability and Reactivity

CHEMICAL STABILITY: Stable under normal conditions of use and storage.

INCOMPATIBILITY: Nitric Acid

HAZARDOUS DECOMPOSITION PRODUCTS: Oxides of Carbon and Potassium.

HAZARDOUS POLYMERIZATION: Will not occur.

Section 11. Toxicological Information

LD50, Oral, Rat: >3200 mg/kg (Potassium Acid Phthalate), details of toxic effects not reported other than lethal dose value.

Section 12. Ecological Information

ECOTOXICOLOGICAL INFORMATION: No information found.

CHEMICAL FATE INFORMATION: No information found.

Section 13. Disposal Considerations

Dilute with water, neutralize with weak sodium hydroxide solution, and then flush to sewer if local regulations allow. If not allowed, save for recovery or recycling in an approved waste disposal facility. Always dispose of in accordance with local, state and federal regulations.

Section 14. Transport Information (Not meant to be all inclusive)

D.O.T. SHIPPING NAME:	Not regulated
D.O.T. HAZARD CLASS:	None
U.N. / N.A. NUMBER:	None
PACKING GROUP:	None
D.O.T. LABEL:	None

Section 15. Regulatory Information (Not meant to be all inclusive - selected regulation represented)

OSHA STATUS: The above items either do not contain any specifically hazardous material or the potentially hazardous material is present in such low concentration that the items do not present any immediate threat to health and safety. These items do not meet the OSHA Hazard Communication Standard (29 CFR 1910.1200) definition of a hazardous material.

TSCA STATUS: All components of this solution are listed on the TSCA Inventory.
CERCLA REPORTABLE QUANTITY: Not reportable
SARA TITLE III:

SECTION 302 EXTREMELY HAZARDOUS SUBSTANCES: No
SECTION 311/312 HAZARDOUS CATEGORIES: No
SECTION 313 TOXIC CHEMICALS: No

RCRA STATUS: No

CALIFORNIA PROPOSITION 65: Not listed

Section 16. Other Information

NFPA® Ratings:	**Health: 1**	**Flammability: 0**	**Reactivity: 0**	**Special Notice Key: None**
HMIS® Ratings:	**Health: 1**	**Flammability: 0**	**Reactivity: 0**	**Protective Equipment: B (Protective eyewear, gloves)**

Rev 1, 10-16-2000: (Section 1) added catalog number 35653-01.
Rev 2, 03-25-2003: Reviewed and approved.
Rev 3, 03-20-2006: Reviewed and approved.

When handled properly by qualified personnel, the product described herein does not present a significant health or safety hazard. Alteration of its characteristics by concentration, evaporation, addition of other substances, or other means may present hazards not specifically addressed herein and which must be evaluated by the user. The information furnished herein is believed to be accurate and represents the best data currently available to us. No warranty, expressed or implied, is made and RICCA CHEMICAL COMPANY assumes no legal responsibility or liability whatsoever resulting from its use.

OAKTON®

MATERIAL SAFETY DATA SHEET

Section 1. Chemical Product and Company Identification

Catalog Number(s) 00654-04, 35654-04, 05942-41, 05942-42, 05942-44, 05942-45, 35653-02	
Product Identity BUFFER, Standard, pH 7.00 (Color Coded Green)	
Manufacturer's Name RICCA CHEMICAL COMPANY	Emergency Telephone Number (24 hr) CHEMTREC®: 800-424-9300
Address (Number, Street, City, State, and ZIP Code) P.O. Box 13090	Telephone Number For Information 817-461-5601
Arlington, Texas 76094	Date Prepared 3-8-2000

Section 2. Composition / Information on Ingredients

		Percent	Exposure Limits	
Component	CAS Registry #	Concentration	ACGIH TLV	OSHA PEL
Sodium Phosphate, Dibasic	7558-79-4	< 1	N/A	N/A
Potassium Phosphate, Monobasic	7778-77-0	< 1	N/A	N/A
Preservative* *(No Mercury Compounds or Formaldehyde)	Proprietary	< 0.1	N/A	N/A
Inert Dye	Proprietary	< 0.1	N/A	N/A
Water, Deionized	7732-18-5	Balance	N/A	N/A

Section 3. Hazards Identification

☆☆

EMERGENCY OVERVIEW

Non-flammable, non-toxic, non-corrosive. Does not present any significant health hazards. May cause irritation. Wash areas of contact with water

☆☆

POTENTIAL HEALTH EFFECTS:

TARGET ORGANS: eyes, skin.

EYE CONTACT: May cause slight irritation.

INHALATION: May cause allergic respiratory reaction to those allergic to phosphates.

SKIN CONTACT: May cause slight irritation to those allergic to phosphates.

INGESTION: Large doses may cause stomach upset.

CHRONIC EFFECTS / CARCINOGENICITY:

IARC – No
NTP – No
OSHA – No

TERATOLOGY (BIRTH DEFECT) INFORMATION:

No information found in "Registry of Toxic Effects of Chemical Substances" or other information sources.

REPRODUCTION INFORMATION:

No information found in "Registry of Toxic Effects of Chemical Substances" or other information sources.

MATERIAL SAFETY DATA SHEET

Section 4. First Aid Measures – In all cases, seek qualified evaluation.

EYE CONTACT: Irrigate immediately with large quantity of water for at least 15 minutes. Call a physician if irritation develops.

INHALATION: Remove to fresh air. Give artificial respiration if necessary. If breathing is difficult, give oxygen.

SKIN CONTACT: Flush with plenty of water for at least 15 minutes. Call a physician if irritation develops.

INGESTION: Dilute with water or milk. Call a physician if necessary.

Section 5. Fire Fighting Measures

FLAMMABLE PROPERTIES:

FLASH POINT:	N/A	METHOD USED:	N/A

FLAMMABLE LIMITS

LFL:	N/A	UFL:	N/A

EXTINGUISHING MEDIA: Use any means suitable for extinguishing surrounding fire.

FIRE & EXPLOSION HAZARDS: Not considered to be a fire or explosion hazard.

FIRE FIGHTING INSTRUCTIONS: Use normal procedures/instructions.

FIRE FIGHTING EQUIPMENT: Use protective clothing and breathing equipment appropriate for the surrounding fire.

Section 6. Accidental Release Measures

Absorb with suitable material (vermiculite, clay, etc.) and dispose of in accordance with local regulations. Check with local agencies for the proper disposal of phosphate containing solutions.

Section 7. Handling and Storage

As with all chemicals, wash hands thoroughly after handling. Avoid contact with eyes and skin. Protect from freezing and physical damage. SAFETY STORAGE CODE: GENERAL

Section 8. Exposure Controls / Personal Protection

ENGINEERING CONTROLS: No specific controls are needed. Normal room ventilation is adequate.

RESPIRATORY PROTECTION: Normal room ventilation is adequate.

SKIN PROTECTION: Chemical resistant gloves.

EYE PROTECTION: Safety glasses or goggles.

Section 9. Physical and chemical Properties

APPEARANCE:	Clear, green liquid	**pH:**	7
ODOR:	Odorless	**BOILING POINT (^{o}C):**	approximately 100
SOLUBILITY IN WATER:	Infinite	**MELTING POINT (^{o}C):**	approximately 0
SPECIFIC GRAVITY:	approximately 1	**VAPOR PRESSURE:**	N/A

Section 10. Stability and Reactivity

CHEMICAL STABILITY: Stable under normal conditions of use and storage.

INCOMPATIBILITY: None identified.

HAZARDOUS DECOMPOSITION PRODUCTS: Phosphorus oxides may form when heated to decomposition.

HAZARDOUS POLYMERIZATION: Will not occur.

Section 11. Toxicological Information

LD50, Oral, Rat: (Sodium Phosphate Dibasic) 17 gm/kg; LD50, Dermal, Rabbit: (Potassium Phosphate Monobasic) >4640 mg/kg; details of toxic effects not reported other than lethal dose value.

Section 12. Ecological Information

ECOTOXICOLOGICAL INFORMATION: No information found.

CHEMICAL FATE INFORMATION: No information found.

Section 13. Disposal Considerations

Dilute with water, then flush to sewer if local regulations allow for the flushing of phosphate containing solutions. If not allowed, save for recovery or recycling in an approved waste disposal facility. Always dispose of in accordance with local, state and federal regulations.

Section 14. Transport Information (Not meant to be all inclusive)

D.O.T. SHIPPING NAME:	Not regulated
D.O.T. HAZARD CLASS:	None
U.N. / N.A. NUMBER:	None
PACKING GROUP:	None
D.O.T. LABEL:	None

Section 15. Regulatory Information (Not meant to be all inclusive - selected regulation represented)

OSHA STATUS: The above items either do not contain any specifically hazardous material or the potentially hazardous material is present in such low concentration that the items do not present any immediate threat to health and safety. These items do not meet the OSHA Hazard Communication Standard (29 CFR 1910.1200) definition of a hazardous material.

TSCA STATUS: All components of this solution are listed on the TSCA Inventory or are mixtures (hydrates) of items listed on the TSCA Inventory.
CERCLA REPORTABLE QUANTITY: Sodium Phosphate, Dibasic - 5,000 pounds.
SARA TITLE III:

SECTION 302 EXTREMELY HAZARDOUS SUBSTANCES: No
SECTION 311/312 HAZARDOUS CATEGORIES: No
SECTION 313 TOXIC CHEMICALS: No

RCRA STATUS: No

CALIFORNIA PROPOSITION 65: Not listed.
PENNSYLVANIA: Sodium Phosphate Dibasic is listed as an environmental hazard on the state Hazardous Substance list.

Section 16. Other Information

NFPA Ratings:	**Health: 1**	**Flammability: 0**	**Reactivity: 0**	**Special Notice Key: None**
HMIS® Ratings:	**Health: 1**	**Flammability: 0**	**Reactivity: 0**	**Protective Equipment: B (Protective eyewear, gloves)**

Rev 1, 8-25-2000: (Section 2) corrected concentration of preservative from 1 – 2 to < 0.1%.
Rev 2, 03-25-2003: Reviewed and approved, (Section 15) added CERCLA reportable quantity.
Rev 3, 03-20-2006: Reviewed and approved.

When handled properly by qualified personnel, the product described herein does not present a significant health or safety hazard. Alteration of its characteristics by concentration, evaporation, addition of other substances, or other means may present hazards not specifically addressed herein and which must be evaluated by the user. The information furnished herein is believed to be accurate and represents the best data currently available to us. No warranty, expressed or implied, is made and RICCA CHEMICAL COMPANY assumes no legal responsibility or liability whatsoever resulting from its use.

OAKTON® MATERIAL SAFETY DATA SHEET

Section 1. Chemical Product and Company Identification

Catalog Number(s)

00654-08, 35654-08, 05942-61, 05942-62, 05942-64, 05942-65, 05942-66, 05942-67, 35653-03

Product Identity

BUFFER, Standard, pH 10.00; BUFFER, High Accuracy, pH 10.000 (Color Coded Blue)

Manufacturer's Name	Emergency Telephone Number (24 hr)
RICCA CHEMICAL COMPANY	CHEMTREC®: 800-424-9300
Address (Number, Street, City, State, and ZIP Code)	Telephone Number For Information
P.O. Box 13090	817-461-5601
	Date Prepared
Arlington, Texas 76094	3-8-2000

Section 2. Composition / Information on Ingredients

		Percent	Exposure Limits	
Component	CAS Registry #	Concentration	ACGIH TLV	OSHA PEL
Sodium Carbonate	497-19-8	< 1	N/A	N/A
Sodium Bicarbonate	144-55-8	< 1	N/A	N/A
Preservative* *(No Mercury compounds or Formaldehyde)	proprietary	< 0.1	N/A	N/A
Inert Dye	proprietary	< 0.1	N/A	N/A
Water, Deionized	7732-18-5	Balance	N/A	N/A

Section 3. Hazards Identification

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EMERGENCY OVERVIEW

Non-flammable, non-toxic, non-corrosive. Does not present any significant health hazards. Wash areas of contact with water.

☆☆

POTENTIAL HEALTH EFFECTS:

TARGET ORGANS: eyes, skin.

EYE CONTACT: May cause slight irritation.

INHALATION: Not likely to be hazardous by inhalation.

SKIN CONTACT: May cause slight irritation.

INGESTION: Large doses may cause nausea, vomiting, diarrhea and cramps.

CHRONIC EFFECTS / CARCINOGENICITY:

IARC – No
NTP – No
OSHA – No

TERATOLOGY (BIRTH DEFECT) INFORMATION:

Mutation data cited in "Registry of Toxic Effects of Chemical Substances" for Sodium Bicarbonate in rats.

REPRODUCTION INFORMATION:

Reproductive data cited in "Registry of Toxic Effects of Chemical Substances" for Sodium Bicarbonate and Sodium Carbonate in mice.

Section 4. First Aid Measures – In all cases, seek qualified evaluation.

EYE CONTACT: Irrigate immediately with large quantity of water for at least 15 minutes. Call a physician if irritation develops.

INHALATION: Remove to fresh air. Give artificial respiration if necessary. If breathing is difficult, give oxygen.

SKIN CONTACT: Flush with plenty of water for at least 15 minutes. Call a physician if irritation develops.

INGESTION: Dilute with water or milk. Call a physician if necessary.

Section 5. Fire Fighting Measures

FLAMMABLE PROPERTIES:

FLASH POINT: N/A METHOD USED: N/A

FLAMMABLE LIMITS

LFL: N/A UFL: N/A

EXTINGUISHING MEDIA: Use any means suitable for extinguishing surrounding fire.

FIRE & EXPLOSION HAZARDS: Not considered to be a fire or explosion hazard.

FIRE FIGHTING INSTRUCTIONS: Use normal procedures/instructions.

FIRE FIGHTING EQUIPMENT: Use protective clothing and breathing equipment appropriate for the surrounding fire.

Section 6. Accidental Release Measures

Absorb with suitable material and treat as normal refuse. Small amounts of the liquid may be flushed to the drain with excess water. Always dispose of in accordance with local regulations.

Section 7. Handling and Storage

As with all chemicals, wash hands thoroughly after handling. Avoid contact with eyes and skin. Protect from freezing and physical damage. SAFETY STORAGE CODE: GENERAL

Section 8. Exposure Controls / Personal Protection

ENGINEERING CONTROLS: No specific controls are needed. Normal room ventilation is adequate.

RESPIRATORY PROTECTION: Normal room ventilation is adequate.

SKIN PROTECTION: Chemical resistant gloves.

EYE PROTECTION: Safety glasses or goggles.

Section 9. Physical and chemical Properties

APPEARANCE:	Clear, blue colored liquid	**pH:**	10
ODOR:	Odorless	**BOILING POINT (^{O}C):**	approximately 100
SOLUBILITY IN WATER:	Infinite	**MELTING POINT (^{O}C):**	approximately 0
SPECIFIC GRAVITY:	approximately 1	**VAPOR PRESSURE:**	N/A

Section 10. Stability and Reactivity

CHEMICAL STABILITY: Stable under normal conditions of use and storage.

INCOMPATIBILITY: Acids

HAZARDOUS DECOMPOSITION PRODUCTS: Oxides of Sodium.

HAZARDOUS POLYMERIZATION: Will not occur.

Section 11. Toxicological Information

LD50, Oral, Rat: 4090 mg/kg (Sodium Carbonate), 4220 mg/kg (Sodium Bicarbonate), details of toxic effects not reported other than lethal dose value.

Section 12. Ecological Information

ECOTOXICOLOGICAL INFORMATION: No information found.

CHEMICAL FATE INFORMATION: No information found.

Section 13. Disposal Considerations

Dilute with water, then flush to sewer if local regulations allow. If not allowed, save for recovery or recycling in an approved waste disposal facility. Always dispose of in accordance with local, state and federal regulations.

Section 14. Transport Information (Not meant to be all inclusive)

D.O.T. SHIPPING NAME:	Not regulated
D.O.T. HAZARD CLASS:	None
U.N. / N.A. NUMBER:	None
PACKING GROUP:	None
D.O.T. LABEL:	None

Section 15. Regulatory Information (Not meant to be all inclusive - selected regulation represented)

OSHA STATUS: The above items either do not contain any specifically hazardous material or the potentially hazardous material is present in such low concentration that the items do not present any immediate threat to health and safety. These items do not meet the OSHA Hazard Communication Standard (29 CFR 1910.1200) definition of a hazardous material.

TSCA STATUS: All components of this solution are listed on the TSCA Inventory.

CERCLA REPORTABLE QUANTITY: Not reportable

SARA TITLE III:

SECTION 302 EXTREMELY HAZARDOUS SUBSTANCES: No

SECTION 311/312 HAZARDOUS CATEGORIES: No

SECTION 313 TOXIC CHEMICALS: No

RCRA STATUS: No

CALIFORNIA PROPOSITION 65: Not listed.

Section 16. Other Information

NFPA® Ratings:	**Health: 1**	**Flammability: 0**	**Reactivity: 0**	**Special Notice Key: None**
HMIS® Ratings:	**Health: 1**	**Flammability: 0**	**Reactivity: 0**	**Protective Equipment: B (Protective eyewear, gloves)**

Rev 1, 01-15-2003: added catalog number 35653-03.
Rev 2, 03-25-2003: Reviewed and approved.
Rev 3, 03-20-2006: Reviewed and approved.

When handled properly by qualified personnel, the product described herein does not present a significant health or safety hazard. Alteration of its characteristics by concentration, evaporation, addition of other substances, or other means may present hazards not specifically addressed herein and which must be evaluated by the user. The information furnished herein is believed to be accurate and represents the best data currently available to us. No warranty, expressed or implied, is made and RICCA CHEMICAL COMPANY assumes no legal responsibility or liability whatsoever resulting from its use.

Material Safety Data Sheet: **Simple Green® All-Purpose Cleaner and Simple Green® Scrubbing Pad**

Version No. 13005-12B Date of Issue: February 2012 *ANSI-Z400.1-2003 Format*

Section 1: PRODUCT & COMPANY IDENTIFICATION

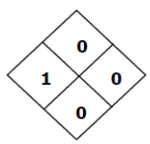
Product Name: Simple Green® All-Purpose Cleaner
Additional Names: Simple Green® Concentrated Cleaner Degreaser Deodorizer
Simple Green® Scrubbing Pad (Fluid in pad only)

Manufacturer's Part Number: **Please refer to page 4*

Company: Sunshine Makers, Inc.
15922 Pacific Coast Highway
Huntington Beach, CA 92649 USA
Telephone: 800-228-0709 ● 562-795-6000 Fax: 562-592-3830
Emergency Phone: Chem-Tel 24-Hour Emergency Service: 800-255-3924

Section 2: HAZARDS IDENTIFICATION

__Emergency Overview:__ **CAUTION. Irritant. This is a Green colored liquid with a sassafras added odor. Scrubbing pad is a green fibrous rectangle infused with Simple Green Cleaner.**



__NFPA/HMIS Rating:__
Health = 1 = slight
Fire, Reactivity, and Special = 0 = minimal

__**Potential Health Effects**__

Eye Contact: Mildly irritating.
Skin Contact: No adverse effects expected under typical use conditions. Prolonged exposure may cause dryness. Chemically sensitive individuals may experience mild irritation.
Ingestion: May cause stomach or intestinal irritation if swallowed.
Inhalation: No adverse effects expected under typical use conditions. Adequate ventilation should be present for prolonged usage in small enclosed areas.

Section 3: COMPOSITION/INFORMATION ON INGREDIENTS

Ingredient	CAS Number	Percent Range
Water	7732-18-5	≥ 78%
2-butoxyethanol	111-76-2	≤ 5%
Ethoxylated Alcohol	68439-46-3	≤ 5%
Tetrapotassium Pyrophosphate	7320-34-5	≤ 5%
Sodium Citrate	68-04-2	≤ 5%
Fragrance	Proprietary Mixture	≤ 1%
Colorant	Proprietary Mixture	≤ 1%

Section 4: FIRST AID MEASURES

If Inhaled: If adverse effect occurs, move to fresh air.
If on skin: If adverse effect occurs, rinse skin with water.
If in eyes: Flush with plenty of water. After 5 minutes of flushing, remove contact lenses, if present. Continue flushing for at least 10 more minutes. If irritation persists seek medical attention.
If ingested: Drink plenty of water to dilute.

Section 5: FIRE FIGHTING MEASURES

This formula is stable, non-flammable, and will not burn. No special procedures necessary
Flammability: Non-flammable
Flash Point: Non-flammable

Suitable Extinguishing Media: Use Dry chemical, CO2, water spray or “alcohol” foam.
Extinguishing Media to Avoid High volume jet water.
Special Exposure Hazards: In event of fire created carbon oxides, oxides of phosphorus may be formed.
Special Protective Equipment: Wear positive pressure self-contained breathing apparatus; Wear full protective clothing.

Section 6: ACCIDENTAL RELEASE MEASURES

Personal Precautions: See section 8 – personal protection.

Environmental Precautions: Do not allow into open waterways and ground water systems.

Method for Clean Up: Dilute with water and rinse into sanitary sewer system or soak up with inert absorbent material.

Section 7: HANDLING AND STORAGE

Handling: Keep container tightly closed. Ensure adequate ventilation. Keep out of reach of children.

Storage: Keep in cool dry area.

Section 8: EXPOSURE CONTROLS / PERSONAL PROTECTION

Exposure Limit Values:

	OSHA PEL	ACGIH TLV
2-butoxyethanol	TWA 50 ppm (240 mg/m^3)	20 ppm (97 mg/m^3)
Tetrapotassium Pyrophosphate		5 mg/m^3

Exposure Controls:
Eye Contact: Use protective glasses if splashing or spray-back is likely.
Respiratory: Use in well ventilated areas.
Skin Contact: Prolonged exposure or dermal sensitive individuals should use protective gloves.

Section 9: PHYSICAL AND CHEMICAL PROPERTIES

Appearance:	Green Liquid	**Vapor Pressure:**	18 mmHg @20^{o}C; 23.5 mmHg @26^{o}C
Odor:	Added Sassafras odor	**Density:**	8.5 lb/gal;
Specific Gravity:	1.010 ± 0.010	**Water Solubility:**	100%
pH:	9.5 ± 0.5	**VOC composite Partial Pressure:**	TBD
Boiling Point:	~210^{o}F (98 ^{o}C)	**VOC:**	CARB Method 310 3.8%
Freezing Point:	~ 32^{o}F (0 ^{o}C)		SCAQMD Method 313 2.8%
Nutrient Content:	Phosphorous: 0.28% Chloride: ~110 ppm	Sulfur: ~180 ppm Fluorine: ~90 ppm	

Section 10: STABILITY AND REACTIVITY

Stability:	Stable
Materials to Avoid:	None known
Hazardous Decomposition Products:	Normal products of combustion - CO, CO2; Oxides of Phosphorous may occur.

Section 11: TOXICOLOGICAL INFORMATION

Acute Toxicity:	Oral LD_{50} (rat)	> 5 g/kg body weight
	Dermal LD_{50} (rabbit)	> 5 g/kg body weight

Toxicity calculated from ingredients using OECD SERIES ON TESTING AND ASSESSMENT Number 33

Carcinogens: No ingredients are listed by OSHA, IARC, or NTP as known or suspected carcinogens.

Section 12: ECOLOGICAL INFORMATION

Hazard to wild mammals:	Low, based on toxicology profile
Hazard to avian species:	Low, based on toxicology profile
Hazard to aquatic organisms:	Low, based on toxicology profile
Chemical Fate Information:	Readily Biodegradable per OECD 301D, Closed Bottle Test

Section 13: DISPOSAL CONSIDERATIONS

Appropriate Method for Disposal:

Unused Product:	*Dilute with water to use concentration and dispose by sanitary sewer.
Used Product:	*This product can enter into clarifiers and oil/water separators. Used product may be hazardous depending on the cleaning application and resulting contaminants.
Empty Containers:	*Triple-rinse with water and offer for recycling if available in your area. Otherwise, dispose as non-hazardous waste.

*Dispose of used or unused product, and empty containers in accordance with the local, State, Provincial, and Federal regulations for your location. Never dispose of used degreasing rinsates into lakes, streams, and open bodies of water or storm drains.

Section 14: TRANSPORT INFORMATION

U.S. Department of Transportation (DOT) / Canadian TDG: Not Regulated

IMO / IDMG:	Not classified as Dangerous
ICAO/ IATA:	Not classified as Dangerous
ADR/RID:	Not classified as Dangerous

U.N. Number	Not Required	Proper Shipping Name:	Detergent Solution
Hazard Class:	Non-Hazardous	Marine Pollutant:	No

Section 15: REGULATORY INFORMATION

All components are listed on: EINECS, TSCA, DSL and AICS Inventory.
No components listed under: Clean Air Act Section 112; Clean Water Act 307 & 311

SARA Title III: 2-butoxyethanol is subject to the reporting requirements of Section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 as Category N230 – Certain Glycol Ethers.

RCRA Status: Not a hazardous waste CERCLA Status : No components listed

State Right To Know Lists

2-butoxyethanol Illinois, Massachusetts, New Jersey, Pennsylvania, Rhode Island

WHMIS Classification – Category D, subcategory 2B, eye irritant

Name	Toxic Substances List – Schedule 1 – CEPA (Canadian Environmental Protection Act)	NPRI Inventory
2-butoxyethanol	Yes	No

This product has been classified according to the hazard criteria of the CPR and the MSDS contains all the information required by Canada's Controlled Products Regulation.

Section 16: OTHER INFORMATION

Questions about the information found on this MSDS should be directed to:
SUNSHINE MAKERS, INC. – TECHNICAL DEPARTMENT
15922 Pacific Coast Hwy. Huntington Beach, CA 92649
Phone: 800/228-0709 [8am-5pm Pacific time, Mon-Fri] *Fax:* 562/592-3830 *Email:* infoweb@simplegreen.com

CAGE CODE 1Z575
GSA/FSS - CONTRACT NO. GS-07F-0065J
Scrubbing Pad GSA/BPA - CONTRACT NO. GS-07F-BSIMP
National Stock Numbers & Industrial Part Numbers:

Simple Green	Part Number	NSN	Size
	13012	7930-01-342-5315	24 oz spray (12/case)
	13005	7930-01-306-8369	1 Gallon (6/case)
	13006	7930-01-342-5316	5 Gallon
	13016	7930-01-342-5317	15 Gallon
	13008	7930-01-342-4145	55 Gallon
	13103	N/A	2oz samples
	13225	N/A	2.5 Gallon
	13275	N/A	275 Gallon tote
	48049	N/A	1 Gallon Conc. w/ 32oz dilution
Scrubbing Pad	10224	7930-01-346-9148	Each (24/case)

Retail Numbers:

Part Number	Size
13002	16 oz Trigger (12/case)
13005	1 Gallon (6/case)
13013	24 oz Trigger (12/case)
13014	67 oz / 2 L (6/case)
13033	32 oz Trigger (12/case)
80007	Tier display holding 13005 (36/Tier)

part number is for both industrial and retail

****International Part Numbers May Differ.**

DISCLAIMER: The information provided with this MSDS is furnished in good faith and without warranty of any kind. Personnel handling this material must make independent determinations of the suitability and completeness of information from all sources to assure proper use and disposal of this material and the safety and health of employees and customers. Sunshine Makers, Inc. assumes no additional liability or responsibility resulting from the use of, or reliance on this information.

MATERIAL SAFETY DATA SHEET

Revision Number A96008F
03/04/11

1. IDENTIFICATION OF THE SUBSTANCE / PREPARATION AND THE COMPANY / UNDERTAKING

Product name	YSI 3682 Zobell Solution
Synonyms	None
Chemical characterization	White powder
Manufacturer, importer, supplier	YSI Inc. 1725 Brannum Lane Yellow Springs, OH 45387 USA
EMERGENCY TELEPHONE NUMBER	(937) 767-7241

2. COMPOSITION / INFORMATION ON INGREDIENTS

CAS	Chemical Name	% Weight	ACGIH TWA	Acute Toxicity	IARC*	NTP*	OSHA*
7447-40-7	Potassium chloride	72-78	None	N/A	N/A	N/A	N/A
14459-95-1	Potassium ferrocyanide	10-15			N/A	N/A	N/A
13746-66-2	Potassium ferrocyanide	10-15			N/A	N/A	N/A

* IARC - Group 1 (Carcinogenic to humans)
* NTP - Report on Carcinogens - Known Carcinogens
* OSHA - Regulated Carcinogens

3. HAZARDS IDENTIFICATION

Emergency Overview

- Use all necessary personal protection when handling this material.

Eye Contact	• Contact with eyes may cause irritation • Wear safety glasses with side shields, • In the event of exposure, flush eyes with water for at least 15 minutes. • Remove contacts and continue to flush eyes, including under the eye lids.
Skin Contact	• Exposure can cause skin irritation. • Wash exposed areas with soap and water for at least 15 minutes. • Remove contaminated clothing, laundry before re-using.
Inhalation	• Dust from this product may cause respiratory irritation • Use with adequate ventilation.
Ingestion	• No effects expected from normal use of this product. Ingestion may cause digestive system upset.
General Advice	• Users with skin conditions (eczema, psoriasis, etc) respiratory conditions (asthma, bronchitis, emphysema, etc) or with chemical sensitivities should take protective precautions
Principle Routes of Exposure	Eyes, absorption, ingestion

4. FIRST AID MEASURES

General Advice	• If exposure symptoms persist, seek medical attention.
Skin Contact	• Wash exposed area with soap and plenty of water. • If skin irritation develops, seek medical attention.
Eye Contact	• Immediately flush with plenty of water after initial flushing, remove any contact lenses and continue flushing for at least 15 minutes • Keep eyes wide open while rinsing

	• If eye irritation persists, seek medical attention
Inhalation	• Move to fresh air in case of accidental inhalation • If a person feels unwell or symptoms of respiratory irritation persist, consult a physician
Ingestion	• Do not swallow. Rinse mouth with water and afterwards drink plenty of water. • For ingestion of large amounts induce vomiting if person is conscious. If conditions persist, seek medical attention.
Notes to Physician	• Treat symptomatically
Protection of First-Aiders	• Use necessary personal protective equipment
Aggravated Medical Conditions	• Users with skin conditions, respiratory conditions, or with chemical sensitivities should take protective precautions.

5. FIRE-FIGHTING MEASURES

Flash Point	NA
Suitable Extinguishing Media	• Not applicable to this product
Extinguishing media which must not be used for safety reasons	• Not applicable to this product

Specific Hazards

Special exposure hazards rising from the substance or preparation itself, its combustion products, or released gases	• Material is not combustible. It may emit toxic fumes when heated, such as hydrogen cyanide, and hydrochloric acid.			
Special protective equipment for firefighters	• As in any fire, wear self contained breathing apparatus and full protective gear			
NFPA (National Fire Protection Association)	Health=3	Reactivity=2	Fire=0	Special=0 (none)
HMIS (Hazardous Material Information System)	Health=3	Reactivity=2	Fire=0	Special=0 (none)

6. ACCIDENTAL RELEASE MEASURES

Personal precautions	• Use necessary personal protective equipment
Environmental precautions	• No information available
Methods for cleaning up	• Sweep up and collect in suitable container for disposal • Avoid formation of dust

7. HANDLING AND STORAGE

Handling

Technical Measures / Precautions	• Use only in areas provided with adequate ventilation
Safe Handling Advice	• Wear personal protective equipment • Avoid contact with skin and eyes. Take necessary personal protective precautions before using this product.

Storage

Technical Measures / Precautions	• Store in a tightly closed container. Store in a cool, dry, well ventilated area away from incompatible substances. • Store in properly labeled container
Incompatible Products	• Avoid strong acids, oxidizing agents

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

Engineering measures	• Ensure adequate ventilation, especially in confined areas • Ensure eyewash station is readily available

Personal protective equipment

Hand Protection	• Wear appropriate protective gloves
Eye protection	• Avoid contact with eyes • Wear safety glasses with side-shields or full face shield.
Respiratory Protection	• Ensure adequate ventilation is available before handling any chemical
Skin and Body Protection	• Lightweight protective clothing • Boots • Apron
Hygiene measures	• Handle in accordance with good industrial hygiene and safety practice • Keep away from food, drink and animal feeding material
Environmental exposure controls	• No information available

9. PHYSICAL AND CHEMICAL PROPERTIES

General Information

Form	Powder
Appearance	White
Odor	unknown

Important Health Safety and Environmental Information

pH	No information
Boiling Point / Range	No information
Flash Point	None
Water Solubility	Infinitely soluble
Specific Gravity	No information

10. STABILITY AND REACTIVITY

Stability	• Stable under normal conditions
Materials to Avoid	• Acids, oxidizing agents
Hazardous Decomposition Products	• When heated, possibly nitrogen oxides and hydrogen cyanide
Polymerization	• Polymerization does not occur

11. TOXICOLOGICAL INFORMATION

Local Effects

Skin Irritation	• May cause skin irritation
Eye Irritation	• Dust may cause eye irritation
Inhalation	• Inhalation of dust may cause irritation of respiratory tissue
Ingestion	• Ingestion of large amounts may cause digestive system upset

Specific Effects

Carcinogenic Effects	• No information available
Mutagenic Effects	• No information available
Reproductive Toxicity	• No information available
Target Organ Effects	• No information available

12. ECOLOGICAL INFORMATION

Component information

CAS	Chemical Name	% Weight	ACGIH*
7447-40-7	Potassium chloride	72-78	N/A
14459-95-1	Potassium ferrocyanide	10-15	N/A
13746-66-2	Potassium ferrocyanide	10-15	N/A

* ACGIH - Occupational Exposure Limits - TWA's
* OSHA - PELs

Product Information

Aquatic Toxicity	No information available.

Other Information

Ozone Depletion Potential; ODP; (R-11=1)	No information available.
Global Warming Potential (GWP)	No information available.
Additional Ecological Information	No information available
Mobility	No information available.
Bioaccumulative Potential	No information available.
Ecotoxicity Effects	No information available
Aquatic Toxicity	No information available.

13. DISPOSAL CONSIDERATIONS

Waste From Residues / Unused Products	Dispose of in accordance with local and state regulations
Contaminated Packaging	Empty containers should be rinsed and disposed of as appropriate for glass and plastic containers.

14. TRANSPORT INFORMATION

DOT	Not regulated
UN-No	
Proper shipping name	
Packing group	
Subsidiary Risk	
Description	

15. REGULATORY INFORMATION

U.S. Inventories

CAS	Chemical Name	% Weight	ACGIH*
7447-40-7	Potassium chloride	72-78	N/A
14459-95-1	Potassium ferrocyanide	10-15	N/A
13746-66-2	Potassium ferrocyanide	10-15	N/A

* ACGIH - Occupational Exposure Limits - TWA's

International Inventories

CAS	Chemical Name	% Weight	EUOED*
7447-40-7	Potassium chloride	72-78	N/A
14459-95-1	Potassium ferrocyanide	10-15	N/A
13746-66-2	Potassium ferrocyanide	10-15	N/A

* EUOED - EU Occupational Exposure Directive (98/24/EC) Indicative Occupational Exposure Limit Values (IOELV)

16. OTHER INFORMATION

Literary Reference	None.
Prepared By	YSI, Inc.

End of Safety Data Sheet.

SAFETY DATA SHEET

Version 5.7
Revision Date 06/08/2018
Print Date 08/05/2018

1. PRODUCT AND COMPANY IDENTIFICATION

1.1 Product identifiers

Product name	:	Hexane
Product Number	:	296090
Brand	:	Sigma-Aldrich
Index-No.	:	601-037-00-0
CAS-No.	:	110-54-3

1.2 Relevant identified uses of the substance or mixture and uses advised against

Identified uses	:	Laboratory chemicals, Synthesis of substances

1.3 Details of the supplier of the safety data sheet

Company	:	Sigma-Aldrich 3050 Spruce Street SAINT LOUIS MO 63103 USA
Telephone	:	+1 800-325-5832
Fax	:	+1 800-325-5052

1.4 Emergency telephone number

Emergency Phone #	:	+1-703-527-3887 (CHEMTREC)

2. HAZARDS IDENTIFICATION

2.1 Classification of the substance or mixture

GHS Classification in accordance with 29 CFR 1910 (OSHA HCS)
Flammable liquids (Category 2), H225
Skin irritation (Category 2), H315
Reproductive toxicity (Category 2), H361
Specific target organ toxicity - single exposure (Category 3), Central nervous system, H336
Specific target organ toxicity - repeated exposure, Oral (Category 2), Nervous system, H373
Aspiration hazard (Category 1), H304
Acute aquatic toxicity (Category 2), H401
Chronic aquatic toxicity (Category 2), H411

For the full text of the H-Statements mentioned in this Section, see Section 16.

2.2 GHS Label elements, including precautionary statements

Pictogram

Signal word: Danger

Hazard statement(s)

H225	Highly flammable liquid and vapour.
H304	May be fatal if swallowed and enters airways.
H315	Causes skin irritation.
H336	May cause drowsiness or dizziness.
H361	Suspected of damaging fertility or the unborn child.
H373	May cause damage to organs (Nervous system) through prolonged or repeated exposure if swallowed.

H411	Toxic to aquatic life with long lasting effects.

Precautionary statement(s)

P201	Obtain special instructions before use.
P202	Do not handle until all safety precautions have been read and understood.
P210	Keep away from heat/sparks/open flames/hot surfaces. No smoking.
P233	Keep container tightly closed.
P240	Ground/bond container and receiving equipment.
P241	Use explosion-proof electrical/ ventilating/ lighting/ equipment.
P242	Use only non-sparking tools.
P243	Take precautionary measures against static discharge.
P260	Do not breathe dust/ fume/ gas/ mist/ vapours/ spray.
P264	Wash skin thoroughly after handling.
P271	Use only outdoors or in a well-ventilated area.
P273	Avoid release to the environment.
P280	Wear protective gloves/ protective clothing/ eye protection/ face protection.
P301 + P310	IF SWALLOWED: Immediately call a POISON CENTER/doctor.
P303 + P361 + P353	IF ON SKIN (or hair): Take off immediately all contaminated clothing. Rinse skin with water/shower.
P304 + P340 + P312	IF INHALED: Remove person to fresh air and keep comfortable for breathing. Call a POISON CENTER/doctor if you feel unwell.
P308 + P313	IF exposed or concerned: Get medical advice/ attention.
P331	Do NOT induce vomiting.
P332 + P313	If skin irritation occurs: Get medical advice/ attention.
P362	Take off contaminated clothing and wash before reuse.
P370 + P378	In case of fire: Use dry sand, dry chemical or alcohol-resistant foam to extinguish.
P391	Collect spillage.
P403 + P233	Store in a well-ventilated place. Keep container tightly closed.
P403 + P235	Store in a well-ventilated place. Keep cool.
P405	Store locked up.
P501	Dispose of contents/ container to an approved waste disposal plant.

2.3 Hazards not otherwise classified (HNOC) or not covered by GHS - none

3. COMPOSITION/INFORMATION ON INGREDIENTS

3.1 Substances

Synonyms	:	n-Hexane
Formula	:	C_6H_{14}
Molecular weight	:	86.18 g/mol
CAS-No.	:	110-54-3
EC-No.	:	203-777-6
Index-No.	:	601-037-00-0
Registration number	:	01-2119480412-44-XXXX

Hazardous components

Component	Classification	Concentration
n-Hexane		
	Flam. Liq. 2; Skin Irrit. 2; Repr. 2; STOT SE 3; STOT RE 2; Asp. Tox. 1; Aquatic Acute 2; Aquatic Chronic 2; H225, H304, H315, H336, H361f, H373, H411	90 - 100 %

For the full text of the H-Statements mentioned in this Section, see Section 16.

4. FIRST AID MEASURES

4.1 Description of first aid measures

General advice
Consult a physician. Show this safety data sheet to the doctor in attendance.Move out of dangerous area.

If inhaled
If breathed in, move person into fresh air. If not breathing, give artificial respiration. Consult a physician.

In case of skin contact
Wash off with soap and plenty of water. Consult a physician.

In case of eye contact
Rinse thoroughly with plenty of water for at least 15 minutes and consult a physician.

If swallowed
Do NOT induce vomiting. Never give anything by mouth to an unconscious person. Rinse mouth with water. Consult a physician.

4.2 Most important symptoms and effects, both acute and delayed
The most important known symptoms and effects are described in the labelling (see section 2.2) and/or in section 11

4.3 Indication of any immediate medical attention and special treatment needed
No data available

5. FIREFIGHTING MEASURES

5.1 Extinguishing media

Suitable extinguishing media
Use water spray, alcohol-resistant foam, dry chemical or carbon dioxide.

5.2 Special hazards arising from the substance or mixture
No data available

5.3 Advice for firefighters
Wear self-contained breathing apparatus for firefighting if necessary.

5.4 Further information
Use water spray to cool unopened containers.

6. ACCIDENTAL RELEASE MEASURES

6.1 Personal precautions, protective equipment and emergency procedures
Use personal protective equipment. Avoid breathing vapours, mist or gas. Ensure adequate ventilation. Remove all sources of ignition. Evacuate personnel to safe areas. Beware of vapours accumulating to form explosive concentrations. Vapours can accumulate in low areas.
For personal protection see section 8.

6.2 Environmental precautions
Prevent further leakage or spillage if safe to do so. Do not let product enter drains. Discharge into the environment must be avoided.

6.3 Methods and materials for containment and cleaning up
Contain spillage, and then collect with an electrically protected vacuum cleaner or by wet-brushing and place in container for disposal according to local regulations (see section 13).

6.4 Reference to other sections
For disposal see section 13.

7. HANDLING AND STORAGE

7.1 Precautions for safe handling
Avoid contact with skin and eyes. Avoid inhalation of vapour or mist.
Flash back possible over considerable distance.Container explosion may occur under fire conditions.Use explosion-proof equipment.Keep away from sources of ignition - No smoking.Take measures to prevent the build up of electrostatic charge.

For precautions see section 2.2.

7.2 Conditions for safe storage, including any incompatibilities

Keep container tightly closed in a dry and well-ventilated place. Containers which are opened must be carefully resealed and kept upright to prevent leakage.
Storage class (TRGS 510): 3: Flammable liquids

7.3 Specific end use(s)

Apart from the uses mentioned in section 1.2 no other specific uses are stipulated

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

8.1 Control parameters

Components with workplace control parameters

Component	CAS-No.	Value	Control parameters	Basis
n-Hexane	110-54-3	TWA	50 ppm	USA. ACGIH Threshold Limit Values (TLV)
	Remarks	Central Nervous System impairment Eye irritation Peripheral neuropathy Substances for which there is a Biological Exposure Index or Indices (see BEI® section) Danger of cutaneous absorption		
		TWA	50 ppm 180 mg/m3	USA. NIOSH Recommended Exposure Limits
		TWA	500 ppm 1,800 mg/m3	USA. Occupational Exposure Limits (OSHA) - Table Z-1 Limits for Air Contaminants
		The value in mg/m3 is approximate.		
		PEL	50 ppm 180 mg/m3	California permissible exposure limits for chemical contaminants (Title 8, Article 107)
		Skin		

Biological occupational exposure limits

Component	CAS-No.	Parameters	Value	Biological specimen	Basis
	-	2,5-Hexanedione	0.4 mg/l	Urine	ACGIH - Biological Exposure Indices (BEI)
	Remarks	End of shift at end of workweek			

8.2 Exposure controls

Appropriate engineering controls

Handle in accordance with good industrial hygiene and safety practice. Wash hands before breaks and at the end of workday.

Personal protective equipment

Eye/face protection

Face shield and safety glasses Use equipment for eye protection tested and approved under appropriate government standards such as NIOSH (US) or EN 166(EU).

Skin protection

Handle with gloves. Gloves must be inspected prior to use. Use proper glove removal technique (without touching glove's outer surface) to avoid skin contact with this product. Dispose of contaminated gloves after use in accordance with applicable laws and good laboratory practices. Wash and dry hands.

Full contact
Material: Nitrile rubber
Minimum layer thickness: 0.4 mm
Break through time: 480 min
Material tested:Camatril® (KCL 730 / Aldrich Z677442, Size M)

Splash contact
Material: Nitrile rubber
Minimum layer thickness: 0.2 mm
Break through time: 59 min
Material tested:Dermatril® P (KCL 743 / Aldrich Z677388, Size M)

data source: KCL GmbH, D-36124 Eichenzell, phone +49 (0)6659 87300, e-mail sales@kcl.de, test method: EN374
If used in solution, or mixed with other substances, and under conditions which differ from EN 374, contact the supplier of the CE approved gloves. This recommendation is advisory only and must be evaluated by an industrial hygienist and safety officer familiar with the specific situation of anticipated use by our customers. It should not be construed as offering an approval for any specific use scenario.

Body Protection
Complete suit protecting against chemicals, Flame retardant antistatic protective clothing., The type of protective equipment must be selected according to the concentration and amount of the dangerous substance at the specific workplace.

Respiratory protection
Where risk assessment shows air-purifying respirators are appropriate use a full-face respirator with multi-purpose combination (US) or type AXBEK (EN 14387) respirator cartridges as a backup to engineering controls. If the respirator is the sole means of protection, use a full-face supplied air respirator. Use respirators and components tested and approved under appropriate government standards such as NIOSH (US) or CEN (EU).

Control of environmental exposure
Prevent further leakage or spillage if safe to do so. Do not let product enter drains. Discharge into the environment must be avoided.

9. PHYSICAL AND CHEMICAL PROPERTIES

9.1 Information on basic physical and chemical properties

a)	Appearance	Form: liquid Colour: colourless
b)	Odour	No data available
c)	Odour Threshold	No data available
d)	pH	7.0
e)	Melting point/freezing point	Melting point/range: -95 °C (-139 °F)
f)	Initial boiling point and boiling range	69 °C (156 °F)
g)	Flash point	-26.0 °C (-14.8 °F) - closed cup
h)	Evaporation rate	15.8
i)	Flammability (solid, gas)	No data available
j)	Upper/lower flammability or explosive limits	Upper explosion limit: 7.7 %(V) Lower explosion limit: 1.2 %(V)
k)	Vapour pressure	341.3 hPa (256.0 mmHg) at 37.7 °C (99.9 °F) 176.0 hPa (132.0 mmHg) at 20.0 °C (68.0 °F)
l)	Vapour density	No data available
m)	Relative density	0.659 g/mL at 25 °C (77 °F)
n)	Water solubility	insoluble
o)	Partition coefficient: n-octanol/water	log Pow: 3.90 - 4.11
p)	Auto-ignition temperature	234.0 °C (453.2 °F)

q) Decomposition temperature — No data available

r) Viscosity — No data available

s) Explosive properties — No data available

t) Oxidizing properties — No data available

9.2 Other safety information
No data available

10. STABILITY AND REACTIVITY

10.1 Reactivity
No data available

10.2 Chemical stability
Stable under recommended storage conditions.

10.3 Possibility of hazardous reactions
Vapours may form explosive mixture with air.

10.4 Conditions to avoid
Exposure to moisture may affect product quality.
Heat, flames and sparks.

10.5 Incompatible materials
Oxidizing agents

10.6 Hazardous decomposition products
Other decomposition products - No data available
Hazardous decomposition products formed under fire conditions. - Carbon oxides
In the event of fire: see section 5

11. TOXICOLOGICAL INFORMATION

11.1 Information on toxicological effects

Acute toxicity

LD50 Oral - Rat - male and female - 16,000 mg/kg
(OECD Test Guideline 401)

LC50 Inhalation - Rat - 4 h - 172 mg/l
Remarks: (RTECS)

LD50 Dermal - Rabbit - > 2,000 mg/kg
Remarks: (ECHA)

Skin corrosion/irritation
Serious eye damage/eye irritation
Respiratory or skin sensitisation
Germ cell mutagenicity
In vitro mammalian cell gene mutation test
Mouse lymphoma test
Result: Positive results were obtained in some in vitro tests.

Ames test
Salmonella typhimurium
Result: negative

Result: negative
(National Toxicology Program)

Carcinogenicity

IARC: No component of this product present at levels greater than or equal to 0.1% is identified as probable, possible or confirmed human carcinogen by IARC.

NTP:	No component of this product present at levels greater than or equal to 0.1% is identified as a known or anticipated carcinogen by NTP.
OSHA:	No component of this product present at levels greater than or equal to 0.1% is on OSHA's list of regulated carcinogens.

Reproductive toxicity
Suspected of damaging the unborn child.

Suspected of damaging fertility.

Specific target organ toxicity - single exposure
May cause drowsiness or dizziness. - Central nervous system

Specific target organ toxicity - repeated exposure
Inhalation - May cause damage to organs through prolonged or repeated exposure. - Nervous system

Aspiration hazard
Aspiration hazard, Aspiration may cause pulmonary oedema and pneumonitis.

Additional Information
RTECS: MN9275000

To the best of our knowledge, the chemical, physical, and toxicological properties have not been thoroughly investigated.
Drowsiness, irritant effects, somnolence
narcosis, Nausea, Tiredness, CNS disorders, paralysis symptoms
Risk of corneal clouding.
It generally applies for aliphatic hydrocarbons with 6 - 18 carbon atoms that they may cause pneumonia, in some cases also pulmonary oedema, upon direct inhalation, i.e. in conditions that can occur only in very special circumstances (nebulizations, spraying, inhalation of aerosols and similar). After absorption of very large quantities: narcosis.

Testes. - Irregularities - Based on Human Evidence

12. ECOLOGICAL INFORMATION

12.1 Toxicity

Toxicity to fish	LC50 - Pimephales promelas (fathead minnow) - 2.5 mg/l - 96 h Remarks: (ECOTOX Database)
Toxicity to daphnia and other aquatic invertebrates	EC50 - Daphnia magna (Water flea) - 2.1 mg/l - 48 h Remarks: (Lit.)

12.2 Persistence and degradability

12.3 Bioaccumulative potential

12.4 Mobility in soil

12.5 Results of PBT and vPvB assessment
PBT/vPvB assessment not available as chemical safety assessment not required/not conducted

12.6 Other adverse effects
An environmental hazard cannot be excluded in the event of unprofessional handling or disposal.
Toxic to aquatic life with long lasting effects.

13. DISPOSAL CONSIDERATIONS

13.1 Waste treatment methods

Product
Burn in a chemical incinerator equipped with an afterburner and scrubber but exert extra care in igniting as this material is highly flammable. Offer surplus and non-recyclable solutions to a licensed disposal company. Contact a licensed professional waste disposal service to dispose of this material.

Contaminated packaging
Dispose of as unused product.

14. TRANSPORT INFORMATION

DOT (US)
UN number: 1208 Class: 3 Packing group: II
Proper shipping name: Hexanes
Reportable Quantity (RQ): 5000 lbs
Poison Inhalation Hazard: No

IMDG
UN number: 1208 Class: 3 Packing group: II EMS-No: F-E, S-D
Proper shipping name: HEXANES
Marine pollutant:yes

IATA
UN number: 1208 Class: 3 Packing group: II
Proper shipping name: Hexanes

15. REGULATORY INFORMATION

SARA 302 Components
No chemicals in this material are subject to the reporting requirements of SARA Title III, Section 302.

SARA 313 Components
The following components are subject to reporting levels established by SARA Title III, Section 313:

	CAS-No.	Revision Date
n-Hexane	110-54-3	2007-07-01

Massachusetts Right To Know Components

	CAS-No.	Revision Date
n-Hexane	110-54-3	2007-07-01

Pennsylvania Right To Know Components

	CAS-No.	Revision Date
n-Hexane	110-54-3	2007-07-01

New Jersey Right To Know Components

	CAS-No.	Revision Date
n-Hexane	110-54-3	2007-07-01

California Prop. 65 Components
This product does not contain any chemicals known to State of California to cause cancer, birth defects, or any other reproductive harm.

16. OTHER INFORMATION

Full text of H-Statements referred to under sections 2 and 3.

Aquatic Acute	Acute aquatic toxicity
Aquatic Chronic	Chronic aquatic toxicity
Asp. Tox.	Aspiration hazard
Flam. Liq.	Flammable liquids
H225	Highly flammable liquid and vapour.
H304	May be fatal if swallowed and enters airways.
H315	Causes skin irritation.
H336	May cause drowsiness or dizziness.
H361	Suspected of damaging fertility or the unborn child.
H361f	Suspected of damaging fertility.
H373	May cause damage to organs (/$/*_2ORG_REP_ORA/$/) through prolonged or repeated exposure if swallowed.
H401	Toxic to aquatic life.
H411	Toxic to aquatic life with long lasting effects.

HMIS Rating
Health hazard: 2

Chronic Health Hazard:	*
Flammability:	3
Physical Hazard	0

NFPA Rating

Health hazard:	2
Fire Hazard:	3
Reactivity Hazard:	0

Further information

The above information is believed to be correct but does not purport to be all inclusive and shall be used only as a guide. The information in this document is based on the present state of our knowledge and is applicable to the product with regard to appropriate safety precautions. It does not represent any guarantee of the properties of the product. Sigma-Aldrich Corporation and its Affiliates shall not be held liable for any damage resulting from handling or from contact with the above product. See www.sigma-aldrich.com and/or the reverse side of invoice or packing slip for additional terms and conditions of sale.

Preparation Information

Sigma-Aldrich Corporation
Product Safety – Americas Region
1-800-521-8956

Version: 5.7 Revision Date: 06/08/2018 Print Date: 08/05/2018

Appendix D
Memorandum Regarding: “NW Natural Response to EPA Comments on NW Natural's Pre-RD Data Gaps Sampling Technical Briefing – Gasco Sediments Site”

6720 SW Macadam Avenue, Suite 125
Portland, Oregon 97219
503.670.1108

ANCHOR QEA

Memorandum

June 10, 2019

To: Sean Sheldrake and Karl Gustavson, U.S. Environmental Protection Agency

From: Ryan Barth, PE, Anchor QEA, LLC

cc: Bob Wyatt, NW Natural
Patty Dost, Pearl Legal Group
Lance Peterson, CDM Smith
Dana Bayuk, Oregon Department of Environmental Quality
Paul Schroeder, U.S. Army Corps of Engineers
Myron Burr, Siltronic Corporation
Michael Murray, Maul Foster & Alongi

Re: NW Natural Response to EPA Comments on NW Natural's Pre-RD Data Gaps Sampling Technical Briefing – Gasco Sediments Site

NW Natural and Anchor QEA, LLC, presented the *Pre-RD Data Gaps Sampling Technical Briefing* to the U.S. Environmental Protection Agency (EPA) and Technical Coordinating Team on November 27, 2018. EPA provided comments to NW Natural in a letter dated December 14, 2018 (Attachment A). This memorandum serves as NW Natural's responses to EPA's comments. The *Pre-Remedial Design Data Gaps Work Plan* (Work Plan) incorporates NW Natural's responses identified herein.

General Comments

EPA General Comment 1

The proposed scope of the sampling generally appears sufficient to support remedial design activities. EPA generally agrees with the proposed data gaps sampling approach presented in the technical briefing on November 27, 2018 but would like to note that the details regarding specific testing approaches and methods are currently lacking. For example, details regarding the testing approaches for assessing nonaqueous phase liquid (NAPL) mobility and evaluating ebullition as a NAPL migration pathway have not been provided. EPA expects these details to be included the Data Gaps Work Plan which will be reviewed by EPA and its partners.

NW Natural Response

These details are included in the Work Plan.

EPA General Comment 2

The Data Gaps Work Plan should discuss the rationale for the sampling activity being proposed and demonstrate that the sampling activity will meet the objectives of the Pre-RD investigation. For example, the work plan must demonstrate that the proposed diver probe transects will be sufficient to delineate the toe of the riprap slope adjacent to the Siltronic property.

NW Natural Response

These details are included in the Work Plan. See NW Natural's response to EPA Specific Comment 10 for more information about the diver probe transects, which have been eliminated from the proposed scope of work.

EPA General Comment 3

The Portland Harbor Record of Decision (ROD) states that sediment contamination exceeding remedial action level (RAL) or principal threat waste (PTW) thresholds may be left in place if it "is present below the feasible depth limit of the excavation technology". The proposed depth of contamination decision framework to be included in the Data Gaps Work Plan should consider the feasible depth limit based on geotechnical, equipment selection, and other factors when establishing criteria for selecting the location and depth of deeper cores.

NW Natural Response

Section 3.4.1 of the Work Plan describes the data sampling objectives to better define and bound the bottom depth of contamination (DOC) to support remedial design within the Interim Project Area, and identifies the scenarios where the DOC is not required due to the ROD flexibility to cap following dredging. Consistent with EPA's feedback during the technical briefing, the Work Plan also states that deeper cores using a different drilling technology will be considered in a subsequent phase of work for elevated chemical mass inventory purposes if remedial design objectives are met with the 20-foot cores, but the DOC remains unbounded in some areas.

EPA General Comment 4

NW Natural should note that EPA will treat riverbank areas with top of bank borings indicating the presence of product as a NAPL/not reliably contained (NRC) PTW bank regardless of the presence/absence of product in borings at the bottom of the bank.

NW Natural Response

As described in Section 3.3.1 of the Work Plan, NW Natural proposes the collection of eight angled top of riverbank borings to characterize the wedge of riverbank soil material between the toe of slope and the top of the riverbank. The boring locations are proposed based on their location downgradient from uplands areas containing dense nonaqueous phase liquid (DNAPL) deemed potentially mobile in the Fill Water-Bearing Zone. NW Natural requests confirmation that these borings will be used to identify the presence/absence of principal threat waste (PTW)-NAPL and potential PTW-NRC based on site-specific capping demonstrations on the riverbank, not existing non-angled top of riverbank borings.

EPA General Comment 5

The measurement of grain size, total solids, and total organic carbon is not mentioned in the presentation but has been included in other Pre-RD sampling efforts (e.g., at Terminal 4). EPA recommends including these parameters in the Pre-RD sampling at the Gasco site, as they will be relevant for remedial design.

NW Natural Response

These parameters are included in Appendix A of the Work Plan.

Specific Comments

EPA Specific Comment 1

Page 5, Overview of Subsurface Sediment Program, Cap modeling. The paired bulk sediment and porewater data to develop site-specific partitioning coefficients should not be limited to ROD Table 17 VOCs. This is different from text on pages 20-21 which state that ROD Table 17 groundwater cleanup level (CUL) analytes will be analyzed. EPA supports the latter – i.e., all ROD Table 17 groundwater CUL analytes should be used to develop site-specific partitioning coefficients. EPA's preference is to use porewater sampling results for the cap modeling effort unless it can be demonstrated that the use of site-specific partitioning coefficients is acceptable in terms of uncertainty in the partitioning coefficient estimates. As stated in EPA's comments on the *NW Natural Proposed Spring 2018 Interim Pre-Remedial Design Data Gaps Field Sampling Memorandum*, "EPA requires that porewater concentrations derived from site-specific partitioning coefficients should be compared to measured porewater concentrations at multiple locations to demonstrate accuracy of the partitioning coefficients being proposed. The proposed partitioning coefficients should also be compared with other sites to ensure consistency with other field-measured partitioning coefficients."

NW Natural Response

As discussed in detail in Appendix D of the *Pre-Remedial Basis of Design Technical Evaluations Work Plan* (TEWP), paired surface bulk sediment and porewater samples were collected throughout the Interim Project Area and used to attempt to develop site-specific equilibrium partition coefficients for the full list of analytes with a ROD Table 17 groundwater CUL. The paired surface sediment and porewater data were found to be sufficient to develop site-specific equilibrium partitioning coefficients for most analytes with a ROD Table 17 groundwater CUL (e.g., polycyclic aromatic hydrocarbons [PAHs] and metals). For the remainder, screening analyses were developed to demonstrate that these other analyte groups (e.g., PAHs, pesticides) would not drive cap design, so additional data is unnecessary.

The only exception was for the volatile organic compounds (VOCs). Several porewater samples contained VOC concentrations below the laboratory method detection limits so an equilibrium relationship between bulk sediment and porewater concentrations could not be determined, and the screening analysis indicated VOCs were likely to be a cap design driver, at least in portions of the site. Therefore, the Work Plan proposes additional paired subsurface bulk sediment and porewater samples in areas previously shown to contain a representative range of VOC sediment concentrations so a site-specific equilibrium partitioning coefficient can be developed for each VOC with a ROD Table 17 groundwater CUL. Consistent with the comment, the analyses presented in Appendix D compared the calculated site-specific partitioning coefficients with literature values. Once the additional VOC data are collected, porewater concentrations derived from site-specific partitioning coefficients will be compared to measured porewater concentrations at multiple locations within the Interim Project Area.

EPA Specific Comment 2

Page 6, Overview of Subsurface Sediment Program (cont.), Barge dewatering treatment. Expand the list of analytes for barge dewatering treatment to include all Table 17 contaminants of concern.

NW Natural Response

NW Natural is proposing to include all Table 17 contaminants in the barge dewatering treatment sample analyses, as shown in Work Plan Appendix B, Table 4d. The results will be compared against the applicable water quality standards identified in Section 3.5.1.1 of the Work Plan.

EPA Specific Comment 3

Page 12, Surface Sediment: SMA Delineation. The evaluation of surface sediment sample locations and sampling density should consider the age of the data and surface sediment samples collected as part of the Portland Harbor Pre-Remedial Design Investigation Studies being performed by the Pre-RD Group. Similar to the forthcoming decision framework for depth of contamination (DOC) evaluation, the sediment management area (SMA) delineation sampling program should include a decision framework for surface sediment. For example, under what circumstances would archived samples be analyzed, and who would make that decision? What if additional samples are needed to delineate the SMAs based on observed exceedances? A decision framework answering these questions should be provided in the Data Gaps Work Plan.

NW Natural Response

NW Natural has considered the age of the data (i.e., temporal relevance) and surface sediment samples collected as part of the Portland Harbor Pre-Remedial Design Group baseline monitoring studies performed by the Pre-RD Group. As described in Section 3.1.1 and shown in Figure 3 of the Work Plan, the existing surface sediment dataset fully delineate the Interim Project Area both outside and inside the channel, so no decision framework is required for the proposed surface sediment sampling use to refine the Interim Project Area. Each of the proposed surface sediment samples will automatically be analyzed as described in Section 3.1.1 of the Work Plan.

EPA Specific Comment 4

Page 16, Subsurface Sediment: DOC Evaluation, 3rd bullet point. EPA agrees with the approach outlined in this bullet point and would like to reinforce that two consecutive 1-ft intervals below the applicable RAL and PTW threshold will be needed to delineate the DOC.

NW Natural Response

As described in Section 3.4.2 of the Work Plan, NW Natural is proposing to sample consecutive 1-foot intervals to determine the DOC at each core location. NW Natural understands that EPA is requiring two consecutive 1-foot intervals below the ROD Table 21 RALs and PTW threshold concentrations and containing no PTW-NAPL to delineate the DOC.

EPA Specific Comment 5

Page 19, Subsurface Sediment: PTW-NAPL Refinement. The PTW-NAPL refinement program should consider the use of additional NAPL identification techniques such as ultraviolet photography.

NW Natural Response

Consistent with the ROD, NW Natural will use the site-specific definition of PTW-NAPL detailed in Section 3.1.1 of the Work Plan. Additional information regarding the identification of PTW-NAPL during core logging and further PTW-NAPL mobility testing, which includes the use of ultraviolet photography, is included in the Work Plan.

EPA Specific Comment 6

Pages 20-21, Subsurface Sediment: Cap Modeling in Dredge Areas and Cap Modeling in Cap-Only Areas. These two slides suggest 20-foot cores for ROD-identified dredge-only areas and 12-foot cores throughout ROD-identified cap-only areas (and potentially deeper intervals if PTW-NAPL is identified). The rationale for this difference in core depth as well as the differences in core intervals for nearshore and offshore transects should be included in the Data Gaps Work Plan.

NW Natural Response

This rationale is included in Section 3.2.2 of the Work Plan.

EPA Specific Comment 7

Pages 20-21, Subsurface Sediment: Cap Modeling in Dredge Areas and Cap Modeling in Cap-Only Areas. NW Natural proposes compositing 4-foot core intervals to support capping demonstration evaluation. Based on the level of detail provided in the presentation, it is not possible to ascertain whether the proposed 4-foot intervals will be sufficient to meet the sampling objectives. Additional details should be included in the Data Gaps Work Plan to demonstrate that the proposed sampling interval will meet the objectives of cap design.

NW Natural Response

Section 3.2.1 of the Work Plan details the proposed capping demonstration evaluation sampling in composited 2- to 3-foot intervals to achieve the sampling objectives.

EPA Specific Comment 8

Page 25, Subsurface Sediment: NAPL Mobility Gas Ebullition Mass Flux, 2nd bullet point. The text states that: "Targeted locations of visual observations TBD based on observations of gas ebullition and surface sheens". EPA recommends the identification of targeted locations be based on a preliminary reconnaissance event in combination with historic observations in the area. The Data Gaps Work Plan should provide details regarding the selection of targeted locations.

NW Natural Response

These details are included in the Section 3.2.2 of the Work Plan.

EPA Specific Comment 9

Page 26, Subsurface Sediment: Waste Disposal Suitability Characterization, 4th bullet point. The text states that: "Bulk sediment samples will be composited from mudline to DOC with archival of 4-foot depth intervals". EPA recommends that this data be evaluated on a dredge management unit (DMU) basis because different DMUs may be closed out in different work windows. As stated on page 27, EPA agrees that additional discussion may be needed to determine the hazardous waste status of material targeted for removal and off-site disposal.

NW Natural Response

NW Natural has determined that the appropriate sampling interval for waste disposal suitability characterization is a composite of the DOC in each proposed core because the full depth of dredge material in a DMU will be mixed in a single barge. The DOC at the proposed locations is currently uncertain (i.e., either unbounded or bounded in large intervals [e.g., 4-foot intervals]), so the DOC will be estimated in the field based on a multiple lines of evidence approach that includes existing nearby sediment characterization information, visual appearance of contamination, and odor. This pre-design characterization will be field verified using the approach described in the *Statement of Work – Gasco Sediments Site*.

The data gaps sampling results are required to develop the DMUs using the evaluations described in Appendix E of the TEWP, so the DMUs cannot be determined prior to completion of the Work Plan sampling activities. Section 4.5 of the TEWP and Section 3.5 of the Work Plan describe the dredge material waste disposal suitability evaluations and associated data gaps sampling activities, including designation of hazardous waste materials.

EPA Specific Comment 10

Page 33, Subsurface Sediment: Diver Probe Survey figure. Based on the location of the diver probe transects, it appears that the proposed transects are limited to rip rap areas adjacent to the Siltronic facility. EPA recommends using geophysical techniques such as ground penetrating radar, side scan sonar, etc. to delineate the presence of rip rap in the project area.

NW Natural Response

NW Natural is no longer proposing the diver probe survey described during the Data Gaps Technical Briefing. Instead, the offshore extent of riprap will be estimated using data collected during a high-resolution paired multibeam bathymetry and light and detection ranging (LiDAR) survey. This work was performed April 22 to 23, 2019, under the *Hydrographic and Topographic Survey Work Plan* approved by EPA on April 15, 2019.

NW Natural will also use the results of the side scan sonar reported in the TEWP. Ground penetrating radar is not commonly used for in-water applications.

EPA Specific Comment 11

Page 36, Subsurface Sediment: Riverbank Borings, 2nd bullet point. The text states that riverbank samples will be analyzed for "…ROD Table 17 analytes with groundwater cleanup levels…". Instead of analytes with groundwater CULs, riverbank soil/sediment CULs should be used for characterization of riverbanks in addition to RAL and NAPL/NRC PTW thresholds, and the riverbank evaluation must also consider erosion potential. Revise the riverbank characterization approach in the Data Gaps Work Plan accordingly. Additionally, the data gaps work plan must provide sufficient rationale for the lack of riverbank soil borings on the Siltronic property.

NW Natural Response

Section 3.3 of the Work Plan describes that riverbank samples will be analyzed for the ROD Table 17 analytes with both groundwater and riverbank soil/sediment CULs, and riverbank erosion potential will be evaluated.

Attachment A

EPA Comments on NW Natural's Pre-RD Data Gaps Sampling Technical Briefing – Gasco Sediments Site

EPA Comments on NW Natural's Pre-RD Data Gaps Sampling Technical Briefing - Gasco Sediments Site Dated November 27, 2018

Comments dated December 14, 2018

The following are the Environmental Protection Agency (EPA) comments on the *Pre-RD Data Gaps Sampling Technical Briefing* (Presentation), presented to EPA and the Technical Coordinating Team by NW Natural and Anchor QEA, LLC on November 27, 2018. The Presentation discusses NW Natural's proposal for data collection to address pre-remedial design data gaps. EPA has the following comments related to the slides and the approach presented on November 27, 2018.

General Comments

1. The proposed scope of the sampling generally appears sufficient to support remedial design activities. EPA generally agrees with the proposed data gaps sampling approach presented in the technical briefing on November 27, 2018 but would like to note that the details regarding specific testing approaches and methods are currently lacking. For example, details regarding the testing approaches for assessing nonaqueous phase liquid (NAPL) mobility and evaluating ebullition as a NAPL migration pathway have not been provided. EPA expects these details to be included the Data Gaps Work Plan which will be reviewed by EPA and its partners.

2. The Data Gaps Work Plan should discuss the rationale for the sampling activity being proposed and demonstrate that the sampling activity will meet the objectives of the Pre-RD investigation. For example, the work plan must demonstrate that the proposed diver probe transects will be sufficient to delineate the toe of the riprap slope adjacent to the Siltronic property.

3. The Portland Harbor Record of Decision (ROD) states that sediment contamination exceeding remedial action level (RAL) or principal threat waste (PTW) thresholds may be left in place if it "is present below the feasible depth limit of the excavation technology". The proposed depth of contamination decision framework to be included in the Data Gaps Work Plan should consider the feasible depth limit based on geotechnical, equipment selection, and other factors when establishing criteria for selecting the location and depth of deeper cores.

4. NW Natural should note that EPA will treat riverbank areas with top of bank borings indicating the presence of product as a NAPL/not reliably contained (NRC) PTW bank regardless of the presence/absence of product in borings at the bottom of the bank.

5. The measurement of grain size, total solids, and total organic carbon is not mentioned in the presentation but has been included in other Pre-RD sampling efforts (e.g., at Terminal 4). EPA recommends including these parameters in the Pre-RD sampling at the Gasco site, as they will be relevant for remedial design.

Specific Comments

1. **Page 5, Overview of Subsurface Sediment Program, Cap modeling.** The paired bulk sediment and porewater data to develop site-specific partitioning coefficients should not be limited to ROD Table 17 VOCs. This is different from text on pages 20-21 which state that ROD Table 17 groundwater cleanup level (CUL) analytes will be analyzed. EPA supports the latter – i.e., all ROD Table 17 groundwater CUL analytes should be used to develop site-specific partitioning coefficients. EPA's preference is to use porewater sampling results for the cap modeling effort unless it can be demonstrated that the use of site-specific partitioning coefficients is acceptable in terms of uncertainty in the partitioning coefficient estimates. As stated in EPA's comments on the *NW Natural Proposed Spring 2018 Interim Pre-Remedial Design Data Gaps Field Sampling Memorandum*, "EPA requires that porewater concentrations derived from site-specific partitioning coefficients should be compared to measured porewater concentrations at multiple locations to demonstrate accuracy of the partitioning coefficients being proposed. The proposed partitioning coefficients should also be compared with other sites to ensure consistency with other field-measured partitioning coefficients."

2. **Page 6, Overview of Subsurface Sediment Program (cont.), Barge dewatering treatment.** Expand the list of analytes for barge dewatering treatment to include all Table 17 contaminants of concern.

3. **Page 12, Surface Sediment: SMA Delineation.** The evaluation of surface sediment sample locations and sampling density should consider the age of the data and surface sediment samples collected as part of the Portland Harbor Pre-Remedial Design Investigation Studies being performed by the Pre-RD Group. Similar to the forthcoming decision framework for depth of contamination (DOC) evaluation, the sediment management area (SMA) delineation sampling program should include a decision framework for surface sediment. For example, under what circumstances would archived samples be analyzed, and who would make that decision? What if additional samples are needed to delineate the SMAs based on observed exceedances? A decision framework answering these questions should be provided in the Data Gaps Work Plan.

4. **Page 16, Subsurface Sediment: DOC Evaluation, 3rd bullet point.** EPA agrees with the approach outlined in this bullet point and would like to reinforce that two consecutive 1-ft intervals below the applicable RAL and PTW threshold will be needed to delineate the DOC.

5. **Page 19, Subsurface Sediment: PTW-NAPL Refinement.** The PTW-NAPL refinement program should consider the use of additional NAPL identification techniques such as ultraviolet photography.

6. **Pages 20-21, Subsurface Sediment: Cap Modeling in Dredge Areas and Cap Modeling in Cap-Only Areas.** These two slides suggest 20-foot cores for ROD-identified dredge-only areas and 12-foot cores throughout ROD-identified cap-only areas (and potentially deeper intervals if PTW-NAPL is identified). The rationale for this difference in core depth as well as the differences in core intervals for nearshore and offshore transects should be included in the Data Gaps Work Plan.

7. **Pages 20-21, Subsurface Sediment: Cap Modeling in Dredge Areas and Cap Modeling in Cap-Only Areas.** NW Natural proposes compositing 4-foot core intervals to support capping demonstration evaluation. Based on the level of detail provided in the presentation, it is not possible to ascertain whether the proposed 4-foot intervals will be sufficient to meet the sampling objectives. Additional details should be included in the Data Gaps Work Plan to demonstrate that the proposed sampling interval will meet the objectives of cap design.

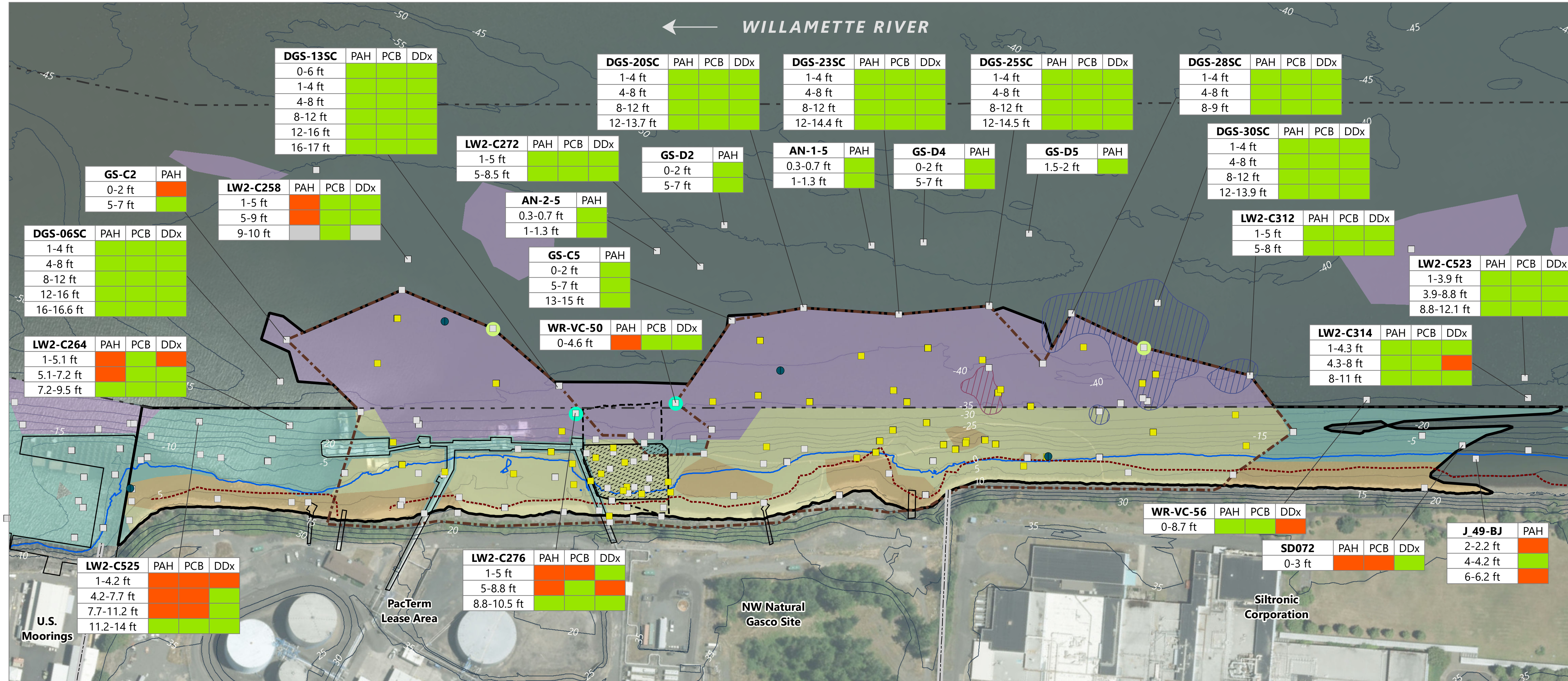
8. **Page 25, Subsurface Sediment: NAPL Mobility Gas Ebullition Mass Flux, 2nd bullet point.** The text states that: "Targeted locations of visual observations TBD based on observations of gas ebullition and surface sheens". EPA recommends the identification of targeted locations be based on a preliminary reconnaissance event in combination with historic observations in the area. The Data Gaps Work Plan should provide details regarding the selection of targeted locations.

9. **Page 26, Subsurface Sediment: Waste Disposal Suitability Characterization, 4th bullet point.** The text states that: "Bulk sediment samples will be composited from mudline to DOC with archival of 4-foot depth intervals". EPA recommends that this data be evaluated on a dredge management unit (DMU) basis because different DMUs may be closed out in different work windows. As stated on page 27, EPA agrees that additional discussion may be needed to determine the hazardous waste status of material targeted for removal and off-site disposal.

10. **Page 33, Subsurface Sediment: Diver Probe Survey figure.** Based on the location of the diver probe transects, it appears that the proposed transects are limited to rip rap areas adjacent to the Siltronic facility. EPA recommends using geophysical techniques such as ground penetrating radar, side scan sonar, etc. to delineate the presence of rip rap in the project area.

11. **Page 36, Subsurface Sediment: Riverbank Borings, 2nd bullet point.** The text states that riverbank samples will be analyzed for "…ROD Table 17 analytes with groundwater cleanup levels…". Instead of analytes with groundwater CULs, riverbank soil/sediment CULs should be used for characterization of riverbanks in addition to RAL and NAPL/NRC PTW thresholds, and the riverbank evaluation must also consider erosion potential. Revise the riverbank characterization approach in the Data Gaps Work Plan accordingly. Additionally, the data gaps work plan must provide sufficient rationale for the lack of riverbank soil borings on the Siltronic property.

Appendix E
Supporting Information for Buried Contamination Evaluation Along Perimeter of Project Area



LEGEND:

- Navigation Channel
- Structures
- Property Line
- Tar Body Removal Action Area (RAPP, Anchor 2005)
- Tar Body Removal Action Pilot Cap
- PTW-NAPL Boundary
- Elevation (feet COP)
- +1.1 feet COP[1]
- Approximate Riprap Boundary[2]
- ROD-Identified SMAs (EPA 2017) Included in the Gasco Sediment Site Interim Project Area[2]

ROD SMA Technology[3]

- Cap
- Dredge
- Dredge in Nav-FMD
- Dredge with Cap
- 2010 Transition Zone Water Vinyl Chloride Area 1 Boundary (Anchor QEA 2012)[4]
- Area 2 – Detected CVOCs in TZW and One Subsurface Sediment Location[5]
- Pre-RD Group Harborwide Monitoring Subsurface Sample Location (AECOM and Geosyntec 2018a)
- Existing Cores with Previously Observed PTW-NAPL
- Existing Subsurface Sample Location
- No Sediment Chemistry (NAPL Observation Only)
- Locations Removed from ROD (Capped/Covered)

Core ID → WR-VC-56	PAH	PCB	DDx
Depth Interval → 0-8.7 ft	Does Not Exceed RAL	Exceeds RAL	Not Analyzed

NOTES:

1. ROD-identified -2 Feet Columbia River Datum Shallow Region elevation threshold converted to City of Portland vertical datum.
2. Estimated from side scan sonar survey conducted by Blue Water Engineering April 2011.
3. All depicted SMA technology and PTW contours taken from the Portland Harbor Superfund Site Record of Decision (2017) without application of the EPA Explanation of Significant Differences (ESD; EPA 2018), which is not yet finalized.
4. Boundary taken from Draft Engineering Evaluation/Cost Analysis, Appendix A, Figure 4.2. Transition zone water screening level exceedances of cis-1,2-dichloroethene identified within this vinyl chloride boundary.
5. Boundary taken from Gasco Sediments Site Statement of Work, Figure 1 (EPA 2009).
6. Bathymetry surveyed by DEA 2018. Topography surveyed by Geometrix 2011.
7. Arrow indicates direction of flow of river.
8. Horizontal datum is NAD83 (HARN 91) Oregon State Plane North, International Feet.
9. Vertical datum is City of Portland (COP), Feet.
10. Aerial imagery from City of Portland 2018.

0 200 Feet

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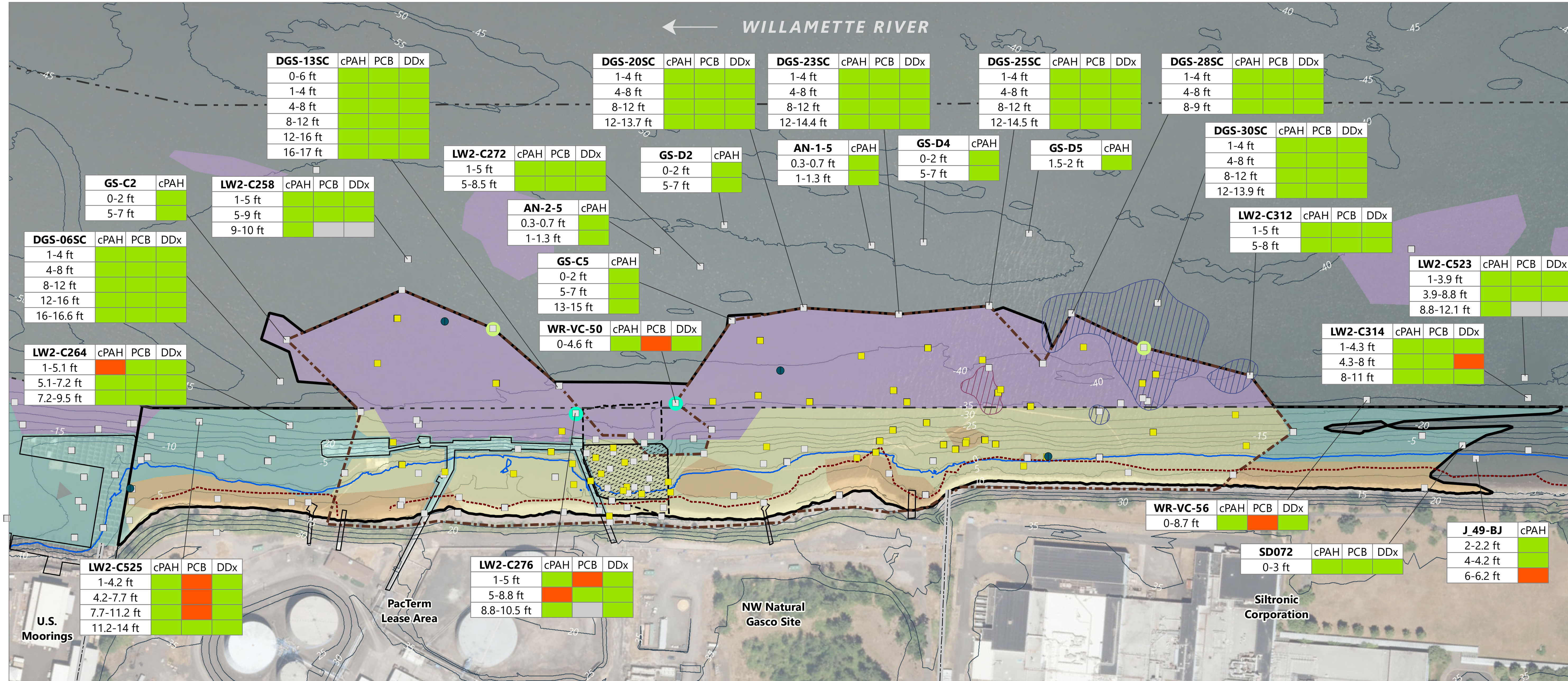
ANCHOR QEA

Figure E-1
Subsurface Sediment RAL Exceedances on Perimeter of Project Area
Supporting Information for Buried Contamination Evaluation Along Perimeter of Project Area
Gasco Sediments Cleanup Action



LEGEND:

- Navigation Channel
- Structures
- Property Line
- Tar Body Removal Action Area (RAPP, Anchor 2005)
- Tar Body Removal Action Pilot Cap
- PTW-NAPL Boundary
- Elevation (feet COP)
- +1.1 feet COP[1]
- Approximate Riprap Boundary[2]
- ROD-Identified SMAs (EPA 2017) Included in the Gasco Sediment Site Interim Project Area[3]

ROD SMA Technology[3]

- Cap
- Dredge
- Dredge in Nav-FMD
- Dredge with Cap
- 2010 Transition Zone Water Vinyl Chloride Area 1 Boundary (Anchor QEA 2012)[4]
- Area 2 – Detected CVOCs in TZW and One Subsurface Sediment Location[5]

- Pre-RD Group Harborwide Monitoring Subsurface Sample Location (AECOM and Geosyntec 2018a)
- Existing Cores with Previously Observed PTW-NAPL
- Existing Subsurface Sample Location
- No Sediment Chemistry (NAPL Observation Only)
- Locations Removed from ROD (Capped/Covered)

Core ID → WR-VC-56 | cPAH | PCB | DDx
Depth Interval → 0-8.7 ft

Does Not Exceed PTW-Highly Toxic
Exceeds PTW-Highly Toxic
Not Analyzed

NOTES:

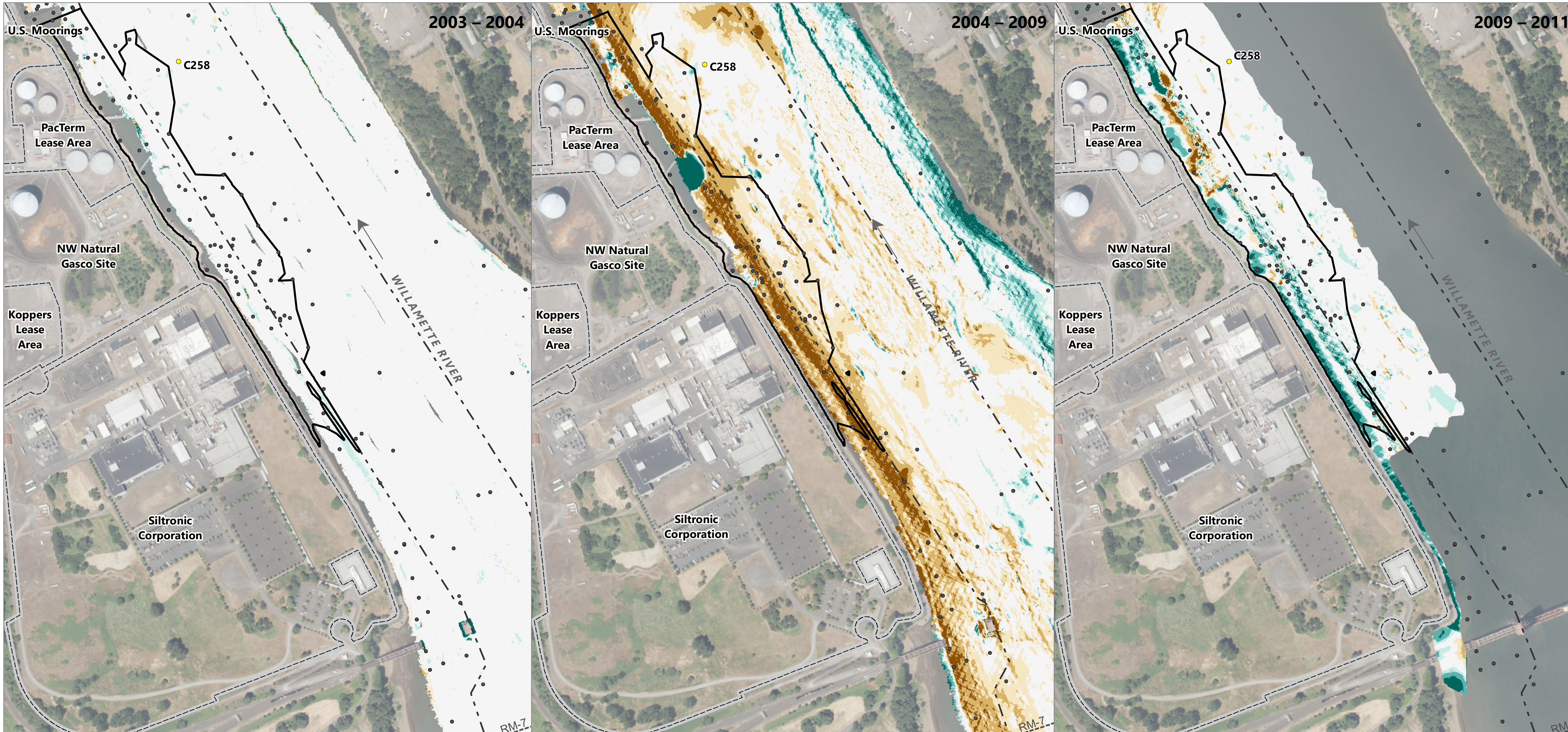
1. ROD-identified -2 Feet Columbia River Datum Shallow Region elevation threshold converted to City of Portland vertical datum.
2. Estimated from side scan sonar survey conducted by Blue Water Engineering April 2011.
3. All depicted SMA technology and PTW contours taken from the Portland Harbor Superfund Site Record of Decision (2017) without application of the EPA Explanation of Significant Differences (ESD; EPA 2018), which is not yet finalized.
4. Boundary taken from Draft Engineering Evaluation/Cost Analysis, Appendix A, Figure 4.2. Transition zone water screening level exceedances of cis-1,2-dichloroethene identified within this vinyl chloride boundary.
5. Boundary taken from Gasco Sediments Site Statement of Work, Figure 1 (EPA 2009).
6. Bathymetry surveyed by DEA 2018. Topography surveyed by Geometrix 2011.
7. Arrow indicates direction of flow of river.
8. Horizontal datum is NAD83 (HARN 91) Oregon State Plane North, International Feet.
9. Vertical datum is City of Portland (COP), Feet.
10. Aerial imagery from City of Portland 2018.

0 200
Feet

Publish Date: 2019/08/09, 9:21 AM | User: alesueur
Filepath: \\orcas\gis\Jobs\NW_Natural_Gas_0029\Gasco_Sediments\Maps\Reports\DataGapsWorkPlan2019\AppendixE\AQ_DGWP_AppxE_Fig02_SubsurfaceDOC_wPTWhighlytoxic.mxd

ANCHOR QEA

Figure E-2
Subsurface Sediment PTW-Highly Toxic Threshold Exceedances on Perimeter of Project Area
Supporting Information for Buried Contamination Evaluation Along Perimeter of Project Area
Gasco Sediments Cleanup Action



LEGEND:

- Navigation Channel
- ROD-Identified SMAs (EPA 2017) Included in the Gasco Sediment Site Interim Project Area[2]
- Property Line
- Focused Subsurface Sample Location
- Existing Subsurface Sample Location

Bathymetric Elevation Differences (feet)

- ≤ 2
- -1.99 - -1
- -0.99 - -0.5
- -0.49 - 0.5
- 0.51 - 1
- 1.01 - 2
- > 2

NOTES:

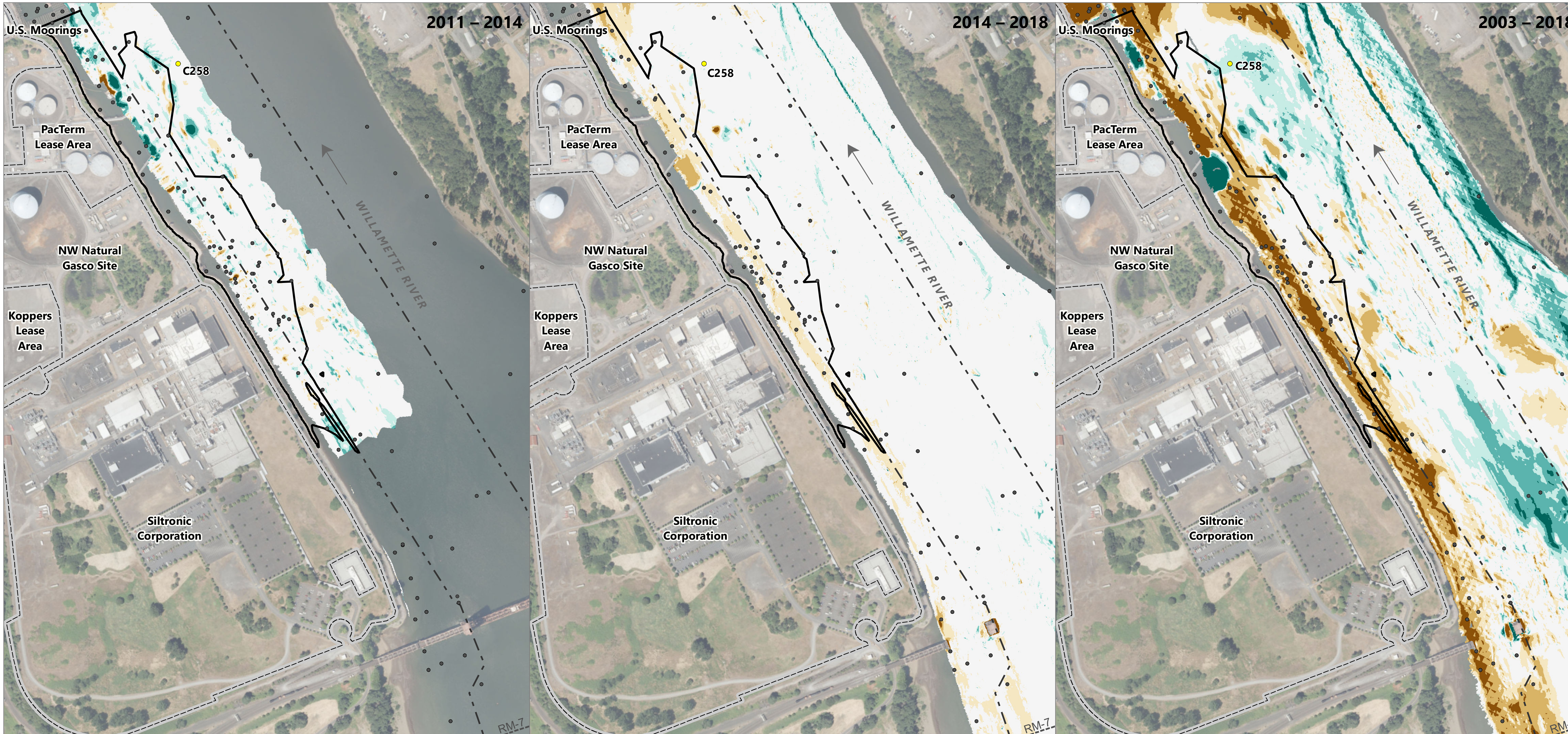
1. Arrow indicates direction of flow of river.
2. Horizontal datum is NAD83 Oregon State Plane North, International Feet.
3. Aerial imagery from City of Portland 2018.
4. Negative and positive bathymetric elevation differences indicate erosion and accretion, respectively. These differences only apply to comparison of the identified years, not the intervening years.

0 500
Feet

Publish Date: 2019/08/12, 9:22 AM | User: alesueur
Filepath: \\orcas\gis\Jobs\NW_Natural_Gas_0029\Gasco_Sediments\Maps\Reports\DataGapsWorkPlan2019\AppendixE\AQ_DGWP_AppxE_Fig03a_bathyDifComparison_03to04_04to09.mxd

ANCHOR QEA

Figure E-3a
Net Bathymetric Change
Supporting Information for Buried Contamination Evaluation Along Perimeter of Project Area
Gasco Sediments Cleanup Action



LEGEND:

- Navigation Channel
- ROD-Identified SMAs (EPA 2017) Included in the Gasco Sediment Site Interim Project Area
- Property Line
- Focused Subsurface Sample Location
- Existing Subsurface Sample Location

Bathymetric Elevation Differences (feet)

- ≤ 2
- -1.99 - -1
- -0.99 - -0.5
- -0.49 - 0.5
- 0.51 - 1
- 1.01 - 2
- > 2

NOTES:
1. Arrow indicates direction of flow of river.
2. Horizontal datum is NAD83 Oregon State Plane North, International Feet.
3. Aerial imagery from City of Portland 2018.
4. Negative and positive bathymetric elevation differences indicate erosion and accretion, respectively. These differences only apply to comparison of the identified years, not the intervening years.

0 500
Feet

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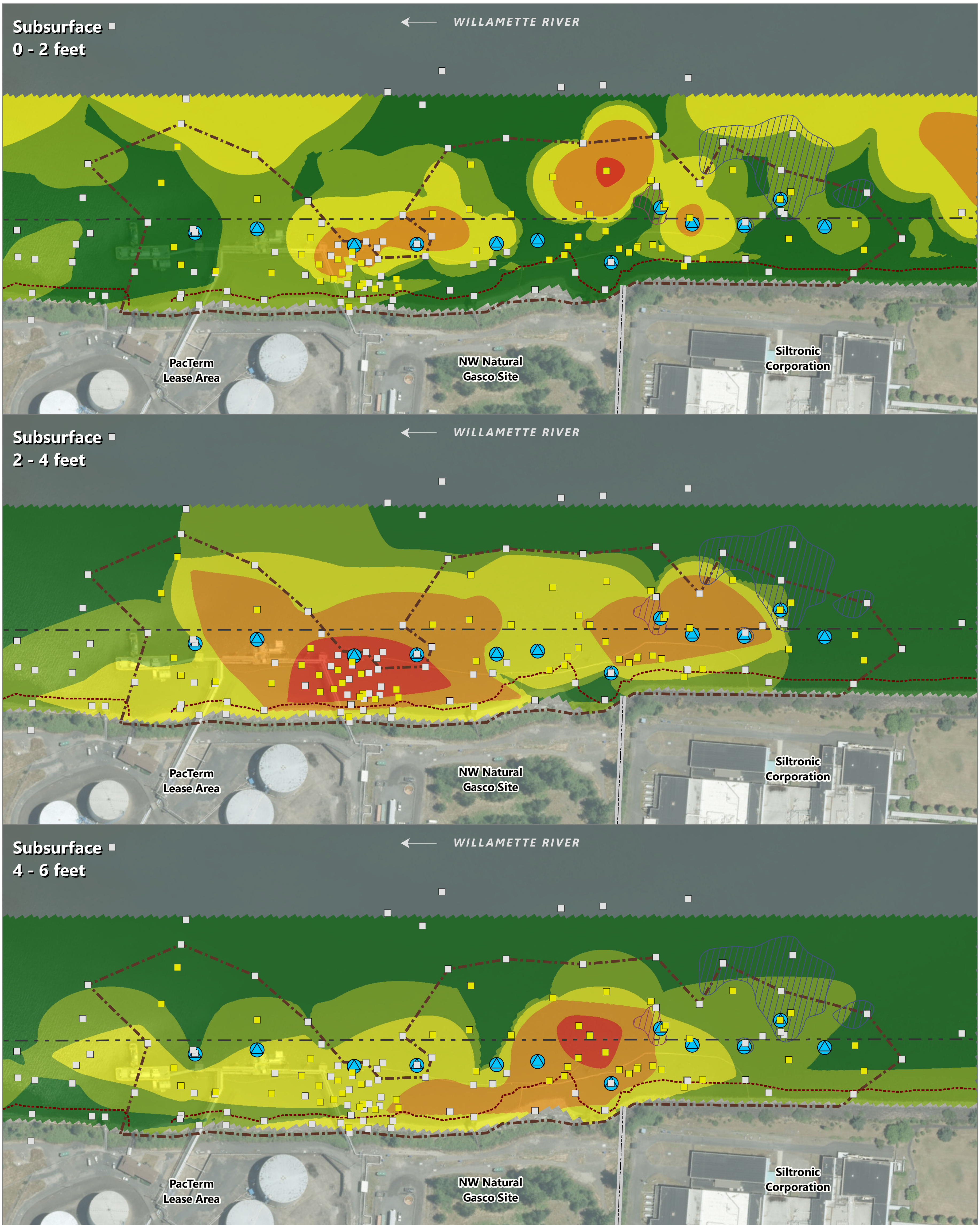
ANCHOR QEA

Figure E-3b
Net Bathymetric Change
Supporting Information for Buried Contamination Evaluation Along Perimeter of Project Area
Gasco Sediments Cleanup Action

Appendix F
Supporting Figures for Paired Subsurface Sediment and Porewater Biogas Generation Potential Locations



LEGEND:

- Navigation Channel
- Property Line
- Approximate Riprap Boundary[1]
- PTW-NAPL Boundary
- 2010 Transition Zone Water Vinyl Chloride Area 1 Boundary (Anchor QEA 2012)[2]
- Area 2 – Detected CVOCs in TZW and One Subsurface Sediment Location[3]
- Existing Cores with Previously Observed PTW-NAPL
- Existing Cores without Observed PTW-NAPL
- Proposed Sampling Locations

Benzene (µg/kg)[4]

- 0 - 10
- 11 - 100
- 101 - 1,000
- 1,001 - 10,000
- 10,001 - 250,000

NOTES:

1. Estimated from side scan sonar survey conducted by Blue Water Engineering April 2011.
2. Boundary taken from Draft Engineering Evaluation/Cost Analysis, Appendix A, Figure 4.2. Transition zone water screening level exceedances of cis-1,2-dichloroethene identified within this vinyl chloride boundary.
3. Boundary taken from Gasco Sediments Site Statement of Work, Figure 1 (EPA 2009).
4. Sediment data obtained from the EPA ROD database, Pre-RD Group 2018 sampling, and NW Natural database.
5. Arrow indicates direction of flow of river.
6. Horizontal datum is NAD83 (HARN 91) Oregon State Plane North, International Feet.
7. Vertical datum is City of Portland (COP), Feet.
8. Aerial imagery from City of Portland 2016.

0 250
Feet

Publish Date: 2019/08/09, 10:09 AM | User: alesueur
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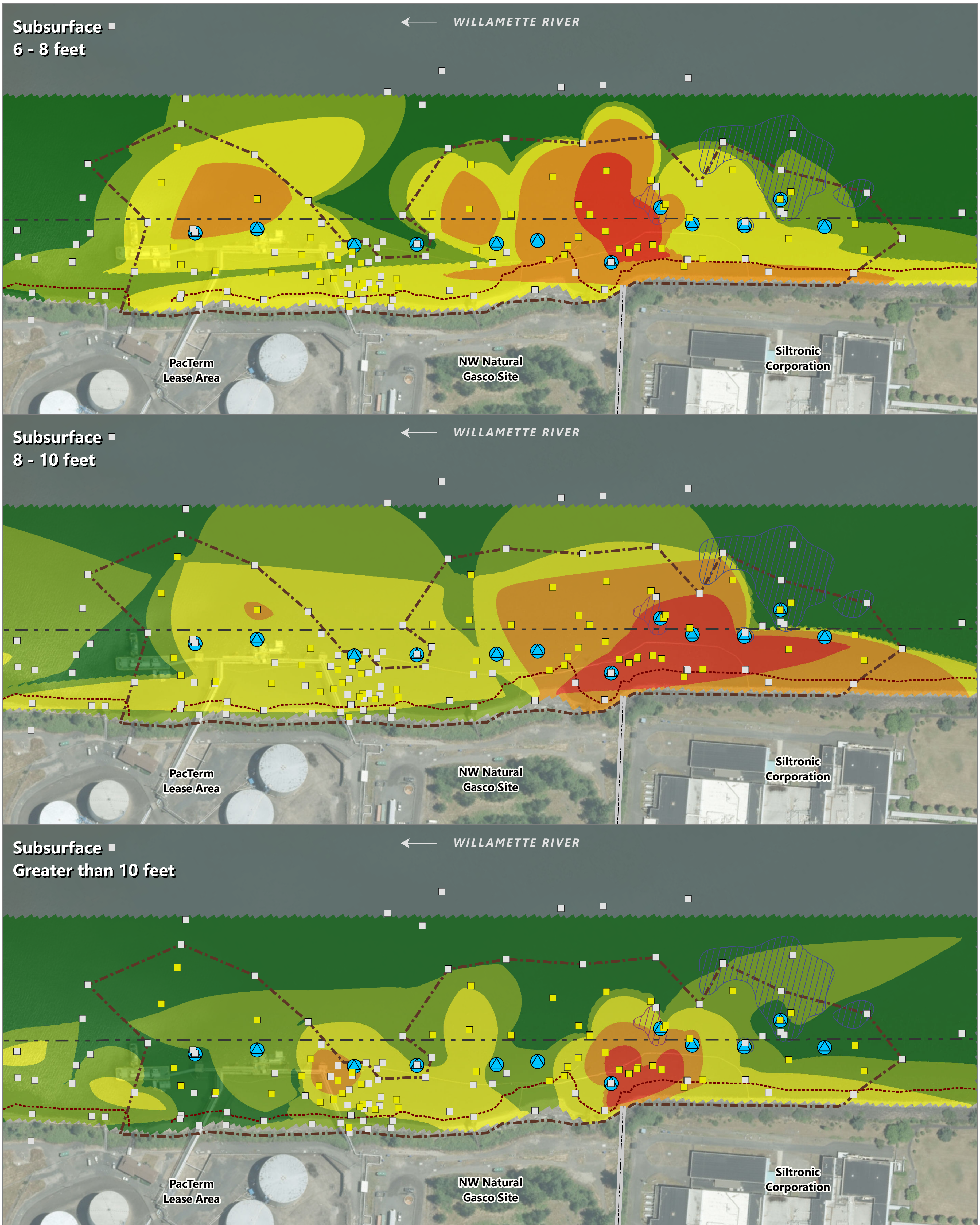
ANCHOR QEA

Figure F-1a
Proposed Paired Subsurface Sediment and Porewater Sampling Locations, Benzene in Sediment From 0 to 6 Feet
Supporting Figures for Paired Subsurface Sediment and Porewater and Biogas Generation Potential Locations
Gasco Sediments Cleanup Action



LEGEND:

- Navigation Channel
- Property Line
- Approximate Riprap Boundary[1]
- PTW-NAPL Boundary
- 2010 Transition Zone Water Vinyl Chloride Area 1 Boundary (Anchor QEA 2012)[2]
- Area 2 – Detected CVOCs in TZW and One Subsurface Sediment Location[3]
- Existing Cores with Previously Observed PTW-NAPL
- Existing Cores without Observed PTW-NAPL
- Proposed Sampling Locations

Benzene (µg/kg)[4]

- 0 - 10
- 11 - 100
- 101 - 1,000
- 1,001 - 10,000
- 10,001 - 250,000

NOTES:

1. Estimated from side scan sonar survey conducted by Blue Water Engineering April 2011.
2. Boundary taken from Draft Engineering Evaluation/Cost Analysis, Appendix A, Figure 4.2. Transition zone water screening level exceedances of cis-1,2-dichloroethene identified within this vinyl chloride boundary.
3. Boundary taken from Gasco Sediments Site Statement of Work, Figure 1 (EPA 2009).
4. Sediment data obtained from the EPA ROD database, Pre-RD Group 2018 sampling, and NW Natural database.
5. Arrow indicates direction of flow of river.
6. Horizontal datum is NAD83 (HARN 91) Oregon State Plane North, International Feet.
7. Vertical datum is City of Portland (COP), Feet.
8. Aerial imagery from City of Portland 2016.

0 250
Feet

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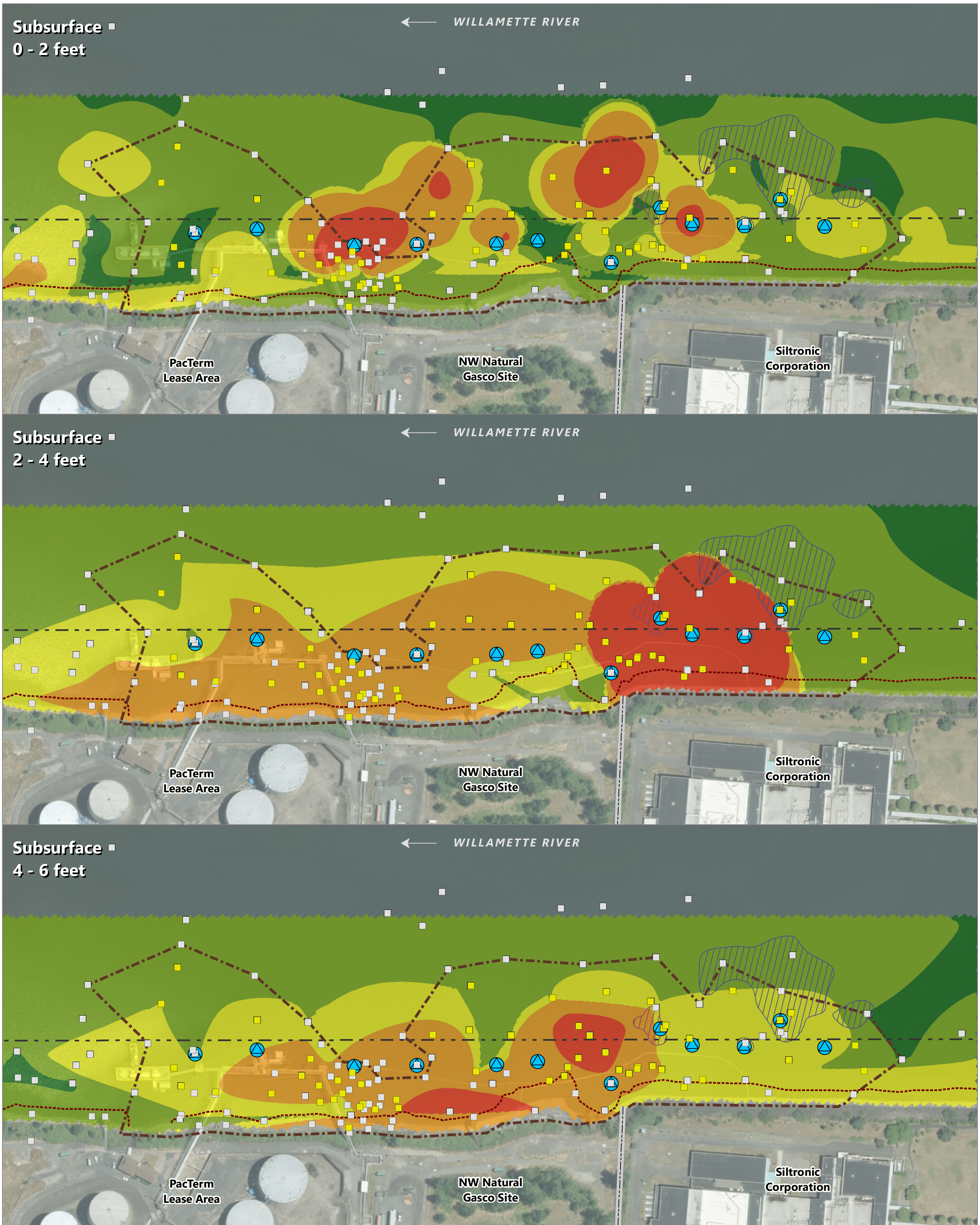
ANCHOR QEA

Figure F-1b

Proposed Paired Subsurface Sediment and Porewater Sampling Locations, Benzene in Sediment From 6 to >10 Feet

Supporting Figures for Paired Subsurface Sediment and Porewater and Biogas Generation Potential Locations
Gasco Sediments Cleanup Action



LEGEND:

- Navigation Channel
- Property Line
- Approximate Riprap Boundary[1]
- PTW-NAPL Boundary
- 2010 Transition Zone Water Vinyl Chloride Area 1 Boundary (Anchor QEA 2012)[2]
- Area 2 – Detected CVOCs in TZW and One Subsurface Sediment Location[3]
- Existing Cores with Previously Observed PTW-NAPL
- Existing Cores without Observed PTW-NAPL
- Proposed Sampling Locations

Trichloroethene (µg/kg)[4]

- 0 - 1
- 2 - 10
- 11 - 100
- 101 - 1,000
- 1,001 - 1,810,000

NOTES:

1. Estimated from side scan sonar survey conducted by Blue Water Engineering April 2011.
2. Boundary taken from Draft Engineering Evaluation/Cost Analysis, Appendix A, Figure 4.2. Transition zone water screening level exceedances of cis-1,2-dichloroethene identified within this vinyl chloride boundary.
3. Boundary taken from Gasco Sediments Site Statement of Work, Figure 1 (EPA 2009).
4. Sediment data obtained from the EPA ROD database, Pre-RD Group 2018 sampling, and NW Natural database.
5. Arrow indicates direction of flow of river.
6. Horizontal datum is NAD83 (HARN 91) Oregon State Plane North, International Feet.
7. Vertical datum is City of Portland (COP), Feet.
8. Aerial imagery from City of Portland 2016.

0 250
Feet

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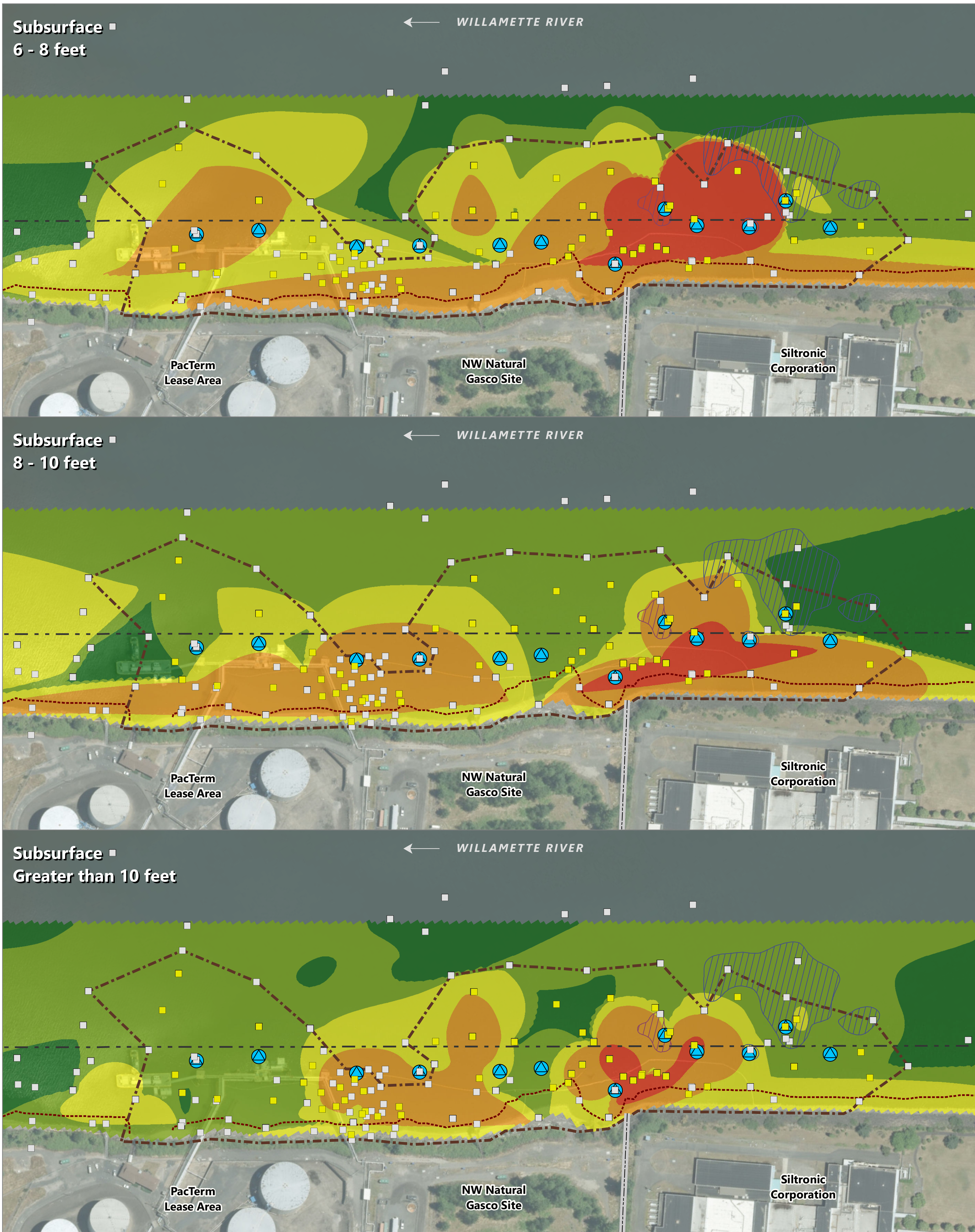
ANCHOR QEA

Figure F-1c

Proposed Paired Subsurface Sediment and Porewater Sampling Locations, Trichloroethene in Sediment From 0 to 6 Feet

Supporting Figures for Paired Subsurface Sediment and Porewater and Biogas Generation Potential Locations
Gasco Sediments Cleanup Action



LEGEND:

- Navigation Channel
- Property Line
- Approximate Riprap Boundary[1]
- PTW-NAPL Boundary
- 2010 Transition Zone Water Vinyl Chloride Area 1 Boundary (Anchor QEA 2012)[2]
- Area 2 – Detected CVOCs in TZW and One Subsurface Sediment Location[3]
- Existing Cores with Previously Observed PTW-NAPL
- Existing Cores without Observed PTW-NAPL
- Proposed Sampling Locations

Trichloroethene (µg/kg)[4]

- 0 - 1
- 2 - 10
- 11 - 100
- 101 - 1,000
- 1,001 - 1,810,000

NOTES:

1. Estimated from side scan sonar survey conducted by Blue Water Engineering April 2011.
2. Boundary taken from Draft Engineering Evaluation/Cost Analysis, Appendix A, Figure 4.2. Transition zone water screening level exceedances of cis-1,2-dichloroethene identified within this vinyl chloride boundary.
3. Boundary taken from Gasco Sediments Site Statement of Work, Figure 1 (EPA 2009).
4. Sediment data obtained from the EPA ROD database, Pre-RD Group 2018 sampling, and NW Natural database.
5. Arrow indicates direction of flow of river.
6. Horizontal datum is NAD83 (HARN 91) Oregon State Plane North, International Feet.
7. Vertical datum is City of Portland (COP), Feet.
8. Aerial imagery from City of Portland 2016.

0 250
Feet

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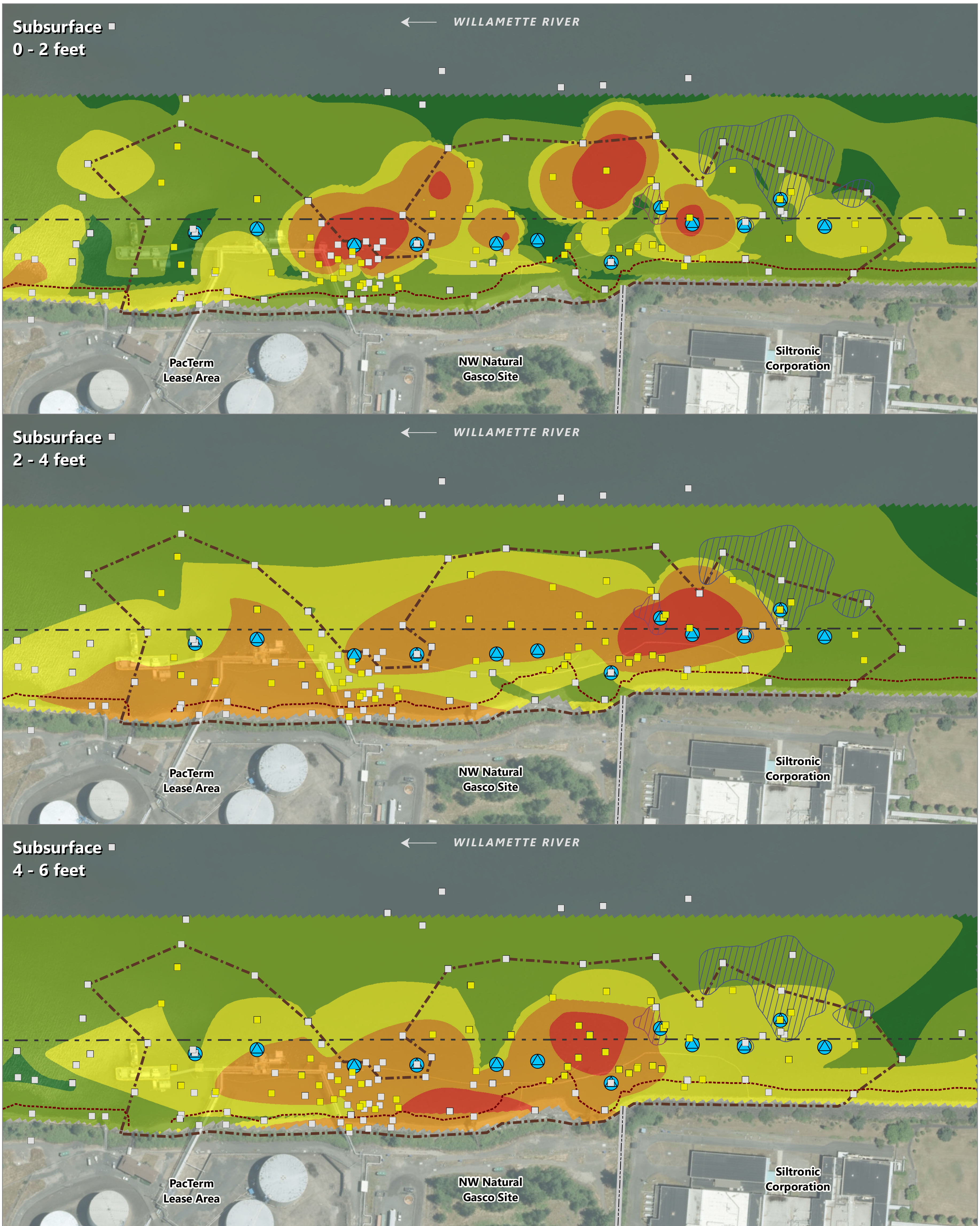
ANCHOR QEA

Figure F-1d
Proposed Paired Subsurface Sediment and Porewater Sampling Locations, Trichloroethene in Sediment From 6 to >10 Feet
Supporting Figures for Paired Subsurface Sediment and Porewater and Biogas Generation Potential Locations
Gasco Sediments Cleanup Action



LEGEND:

- Navigation Channel
- Property Line
- Approximate Riprap Boundary[1]
- PTW-NAPL Boundary
- 2010 Transition Zone Water Vinyl Chloride Area 1 Boundary (Anchor QEA 2012)[2]
- Area 2 – Detected CVOCs in TZW and One Subsurface Sediment Location[3]
- Existing Cores with Previously Observed PTW-NAPL
- Existing Cores without Observed PTW-NAPL
- Proposed Sampling Locations

Vinyl Chloride (µg/kg)[4]

- 0 - 1
- 2 - 10
- 11 - 100
- 101 - 1,000
- 1,001 - 14,000

NOTES:

1. Estimated from side scan sonar survey conducted by Blue Water Engineering April 2011.
2. Boundary taken from Draft Engineering Evaluation/Cost Analysis, Appendix A, Figure 4.2. Transition zone water screening level exceedances of cis-1,2-dichloroethene identified within this vinyl chloride boundary.
3. Boundary taken from Gasco Sediments Site Statement of Work, Figure 1 (EPA 2009).
4. Sediment data obtained from the EPA ROD database, Pre-RD Group 2018 sampling, and NW Natural database.
5. Arrow indicates direction of flow of river.
6. Horizontal datum is NAD83 (HARN 91) Oregon State Plane North, International Feet.
7. Vertical datum is City of Portland (COP), Feet.
8. Aerial imagery from City of Portland 2016.

0 250
Feet

Publish Date: 2019/08/09, 10:19 AM | User: alesueur
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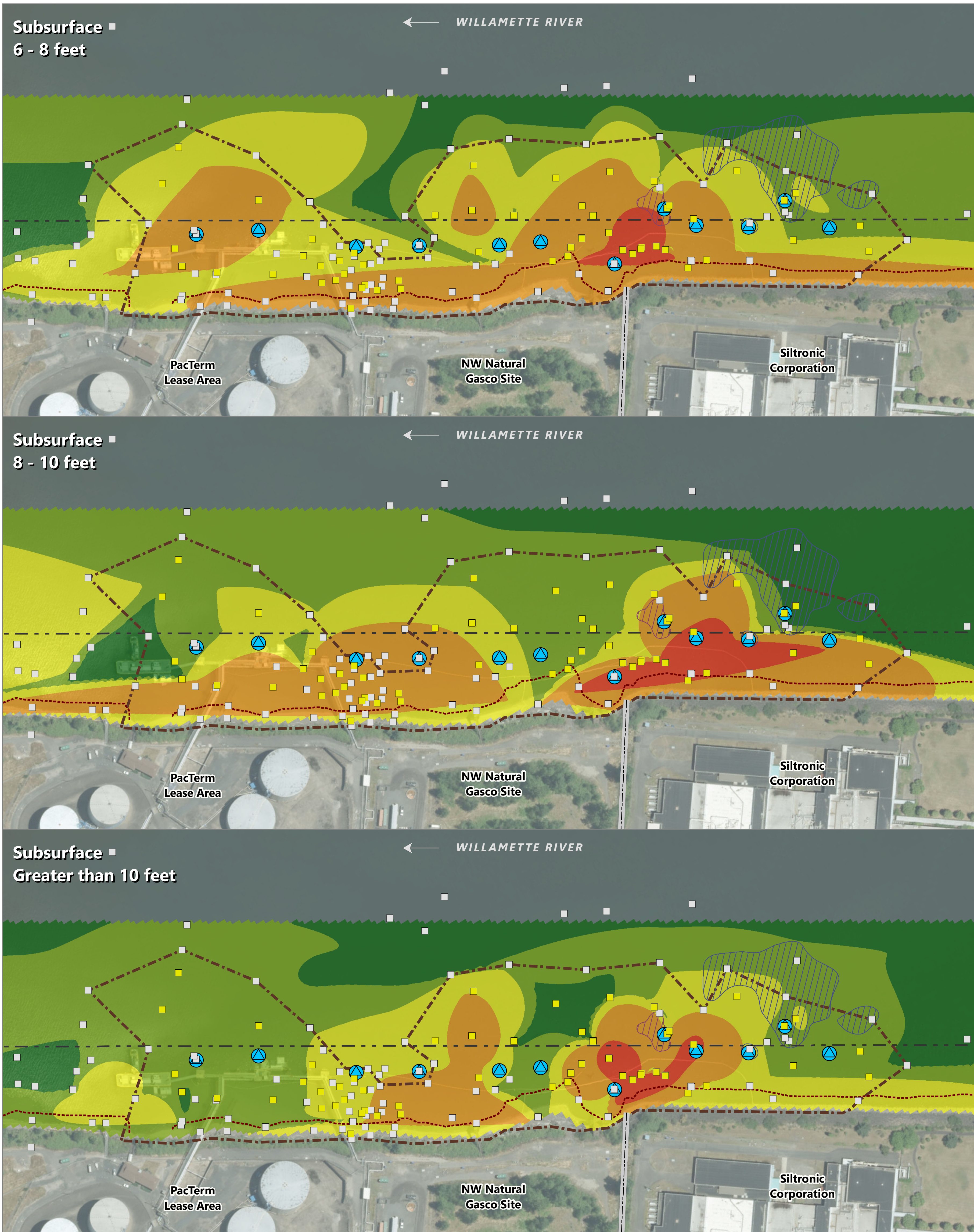
ANCHOR QEA

Figure F-1e
Proposed Paired Subsurface Sediment and Porewater Sampling Locations, Vinyl Chloride in Sediment From 0 to 6 Feet
Supporting Figures for Paired Subsurface Sediment and Porewater and Biogas Generation Potential Locations
Gasco Sediments Cleanup Action



LEGEND:

- Navigation Channel
- Property Line
- Approximate Riprap Boundary[1]
- PTW-NAPL Boundary
- 2010 Transition Zone Water Vinyl Chloride Area 1 Boundary (Anchor QEA 2012)[2]
- Area 2 – Detected CVOCs in TZW and One Subsurface Sediment Location[3]
- Existing Cores with Previously Observed PTW-NAPL
- Existing Cores without Observed PTW-NAPL
- Proposed Sampling Locations

Vinyl Chloride (µg/kg)[4]

- 0 - 1
- 2 - 10
- 11 - 100
- 101 - 1,000
- 1,001 - 14,000

NOTES:

1. Estimated from side scan sonar survey conducted by Blue Water Engineering April 2011.
2. Boundary taken from Draft Engineering Evaluation/Cost Analysis, Appendix A, Figure 4.2. Transition zone water screening level exceedances of cis-1,2-dichloroethene identified within this vinyl chloride boundary.
3. Boundary taken from Gasco Sediments Site Statement of Work, Figure 1 (EPA 2009).
4. Sediment data obtained from the EPA ROD database, Pre-RD Group 2018 sampling, and NW Natural database.
5. Arrow indicates direction of flow of river.
6. Horizontal datum is NAD83 (HARN 91) Oregon State Plane North, International Feet.
7. Vertical datum is City of Portland (COP), Feet.
8. Aerial imagery from City of Portland 2016.

0 250
Feet

Publish Date: 2019/08/09, 10:22 AM | User: alesueur
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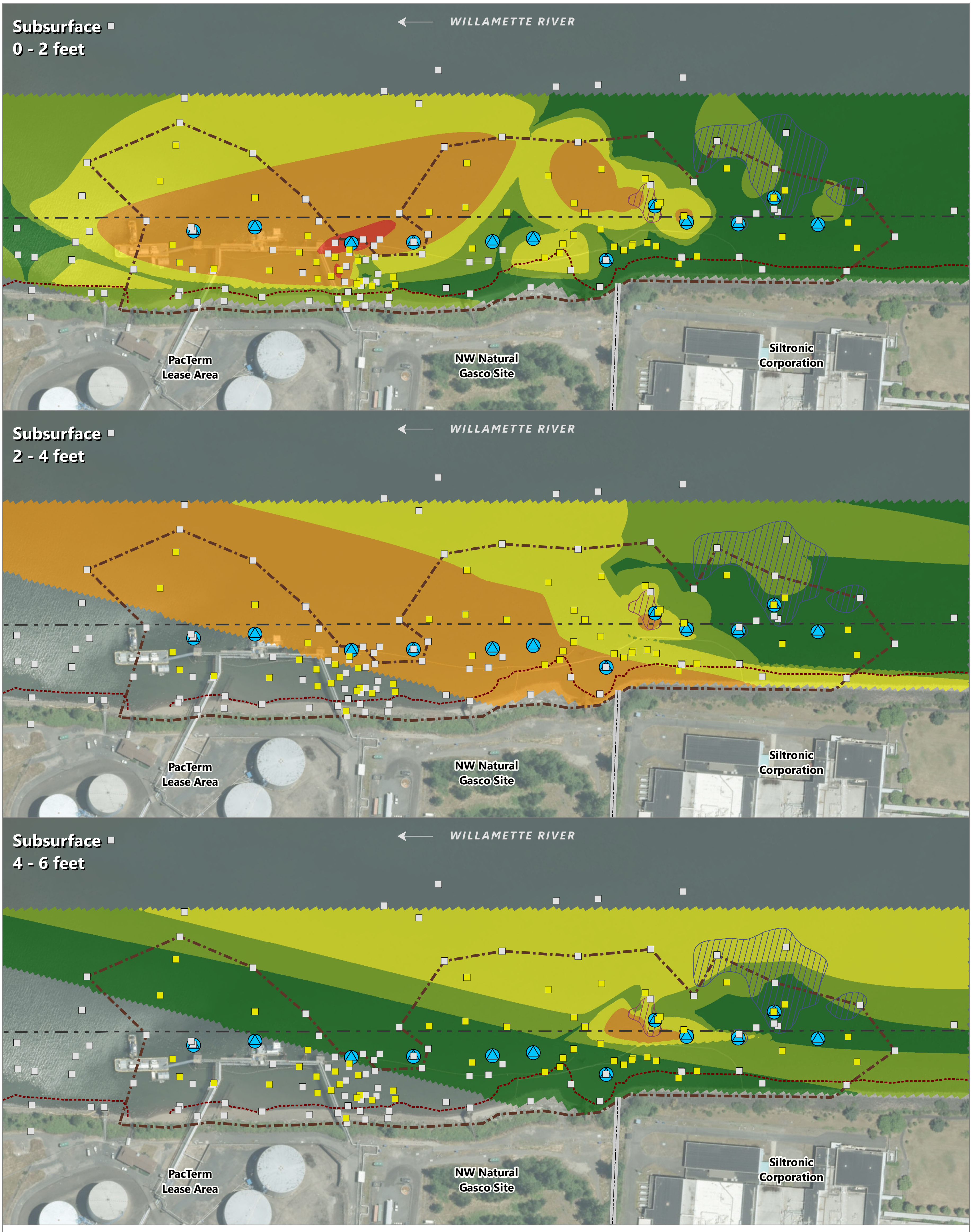
ANCHOR QEA

Figure F-1f

Proposed Paired Subsurface Sediment and Porewater Sampling Locations, Vinyl Chloride in Sediment From 6 to >10 Feet

Supporting Figures for Paired Subsurface Sediment and Porewater and Biogas Generation Potential Locations
Gasco Sediments Cleanup Action



LEGEND:

- Navigation Channel
- Property Line
- Approximate Riprap Boundary[1]
- PTW-NAPL Boundary
- 2010 Transition Zone Water Vinyl Chloride Area 1 Boundary (Anchor QEA 2012)[2]
- Area 2 – Detected CVOCs in TZW and One Subsurface Sediment Location[3]
- Existing Cores with Previously Observed PTW-NAPL
- Existing Cores without Observed PTW-NAPL
- Proposed Sampling Locations

Benzene (μg/L)[4]

- 0 - 10
- 11 - 100
- 101 - 1,000
- 1,001 - 10,000
- 10,001 - 250,000

NOTES:

1. Estimated from side scan sonar survey conducted by Blue Water Engineering April 2011.
2. Boundary taken from Draft Engineering Evaluation/Cost Analysis, Appendix A, Figure 4.2. Transition zone water screening level exceedances of cis-1,2-dichloroethene identified within this vinyl chloride boundary.
3. Boundary taken from Gasco Sediments Site Statement of Work, Figure 1 (EPA 2009).
4. Sediment data obtained from the EPA ROD database, Pre-RD Group 2018 sampling, and NW Natural database.
5. Arrow indicates direction of flow of river.
6. Horizontal datum is NAD83 (HARN 91) Oregon State Plane North, International Feet.
7. Vertical datum is City of Portland (COP), Feet.
8. Aerial imagery from City of Portland 2016.

0 250
Feet

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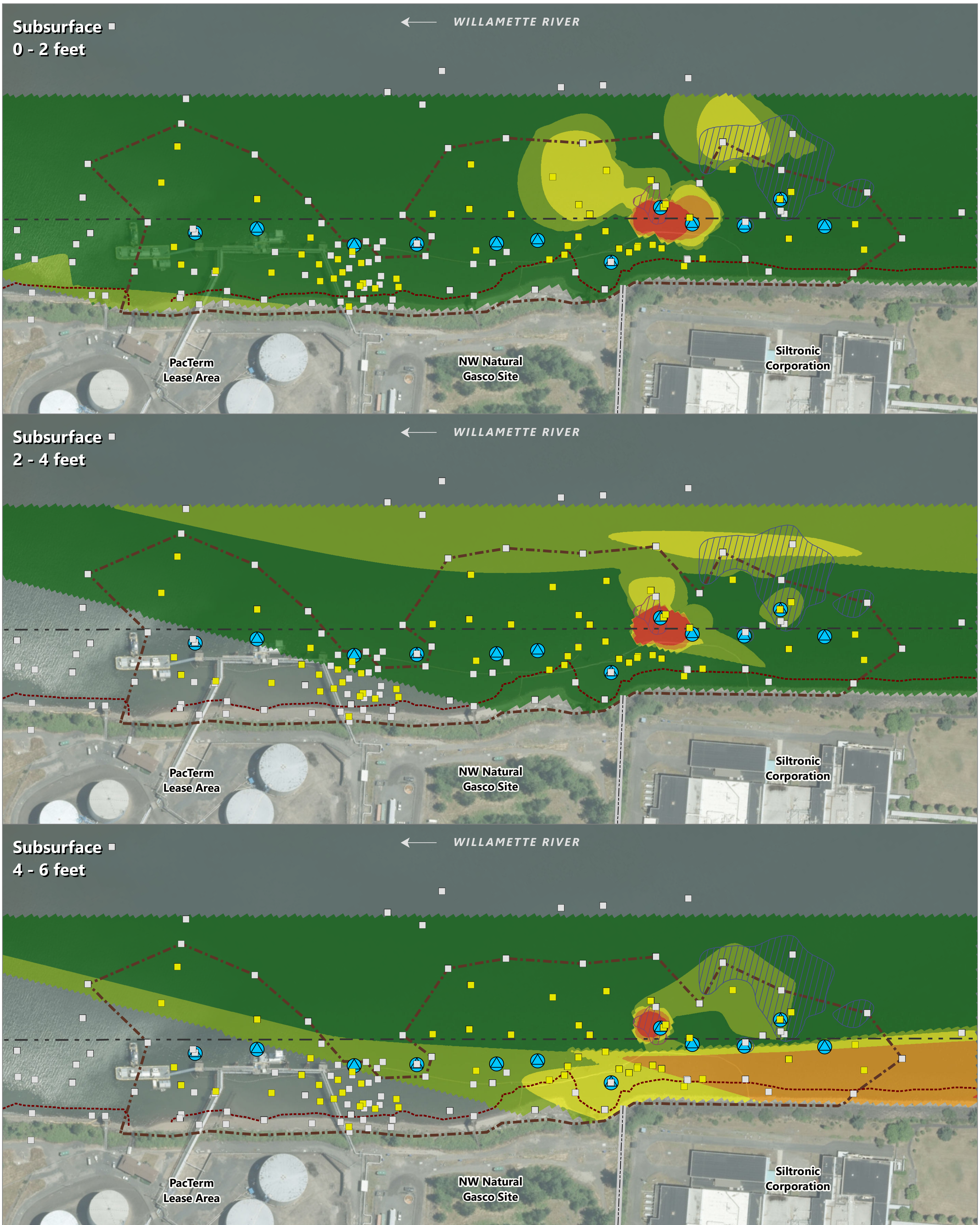
ANCHOR QEA

Figure F-2a

Proposed Paired Subsurface Sediment and Porewater Sampling Locations, Benzene in Porewater From 0 to 6 Feet

Supporting Figures for Paired Subsurface Sediment and Porewater and Biogas Generation Potential Locations
Gasco Sediments Cleanup Action



LEGEND:

- Navigation Channel
- Property Line
- Approximate Riprap Boundary[1]
- PTW-NAPL Boundary
- 2010 Transition Zone Water Vinyl Chloride Area 1 Boundary (Anchor QEA 2012)[2]
- Area 2 – Detected CVOCs in TZW and One Subsurface Sediment Location[3]
- Existing Cores with Previously Observed PTW-NAPL
- Existing Cores without Observed PTW-NAPL
- Proposed Sampling Locations

Trichloroethene (µg/L)[4]

- 0 - 1
- 2 - 10
- 11 - 100
- 101 - 1,000
- 1,001 - 1,810,000

NOTES:

1. Estimated from side scan sonar survey conducted by Blue Water Engineering April 2011.
2. Boundary taken from Draft Engineering Evaluation/Cost Analysis, Appendix A, Figure 4.2. Transition zone water screening level exceedances of cis-1,2-dichloroethene identified within this vinyl chloride boundary.
3. Boundary taken from Gasco Sediments Site Statement of Work, Figure 1 (EPA 2009).
4. Sediment data obtained from the EPA ROD database, Pre-RD Group 2018 sampling, and NW Natural database.
5. Arrow indicates direction of flow of river.
6. Horizontal datum is NAD83 (HARN 91) Oregon State Plane North, International Feet.
7. Vertical datum is City of Portland (COP), Feet.
8. Aerial imagery from City of Portland 2016.

0 250
Feet

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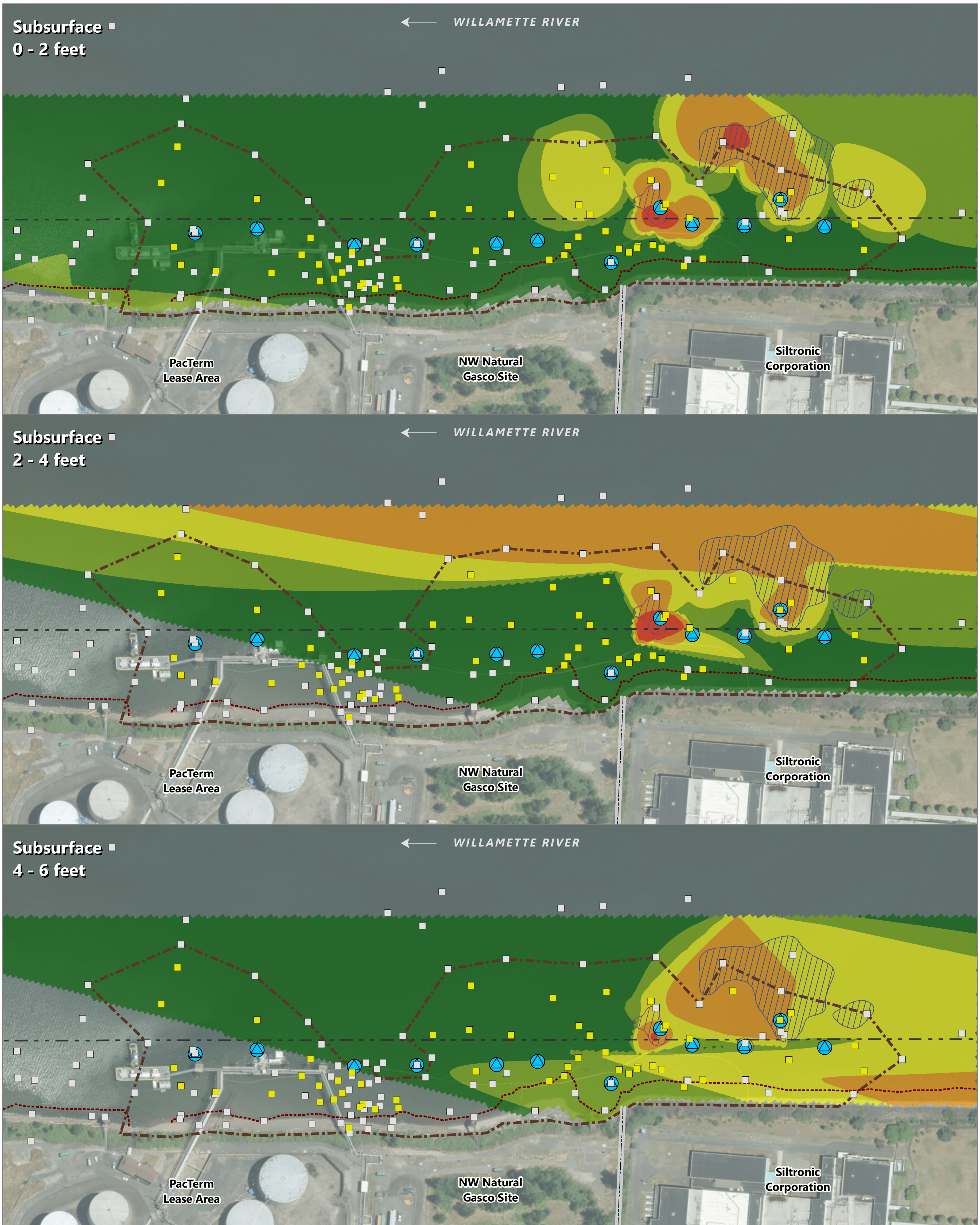
ANCHOR QEA

Figure F-2b

Proposed Paired Subsurface Sediment and Porewater Sampling Locations, Trichloroethene in Porewater From 0 to 6 Feet

Supporting Figures for Paired Subsurface Sediment and Porewater and Biogas Generation Potential Locations
Gasco Sediments Cleanup Action



LEGEND:

- Navigation Channel
- Property Line
- Approximate Riprap Boundary[1]
- PTW-NAPL Boundary
- 2010 Transition Zone Water Vinyl Chloride Area 1 Boundary (Anchor QEA 2012)[2]
- Area 2 – Detected CVOCs in TZW and One Subsurface Sediment Location[3]
- Existing Cores with Previously Observed PTW-NAPL
- Existing Cores without Observed PTW-NAPL
- Proposed Sampling Locations

Vinyl Chloride (µg/L)[4]

- 0 - 1
- 2 - 10
- 11 - 100
- 101 - 1,000
- 1,001 - 14,000

NOTES:

1. Estimated from side scan sonar survey conducted by Blue Water Engineering April 2011.
2. Boundary taken from Draft Engineering Evaluation/Cost Analysis, Appendix A, Figure 4.2. Transition zone water screening level exceedances of cis-1,2-dichloroethene identified within this vinyl chloride boundary.
3. Boundary taken from Gasco Sediments Site Statement of Work, Figure 1 (EPA 2009).
4. Sediment data obtained from the EPA ROD database, Pre-RD Group 2018 sampling, and NW Natural database.
5. Arrow indicates direction of flow of river.
6. Horizontal datum is NAD83 (HARN 91) Oregon State Plane North, International Feet.
7. Vertical datum is City of Portland (COP), Feet.
8. Aerial imagery from City of Portland 2016.

0 250
Feet

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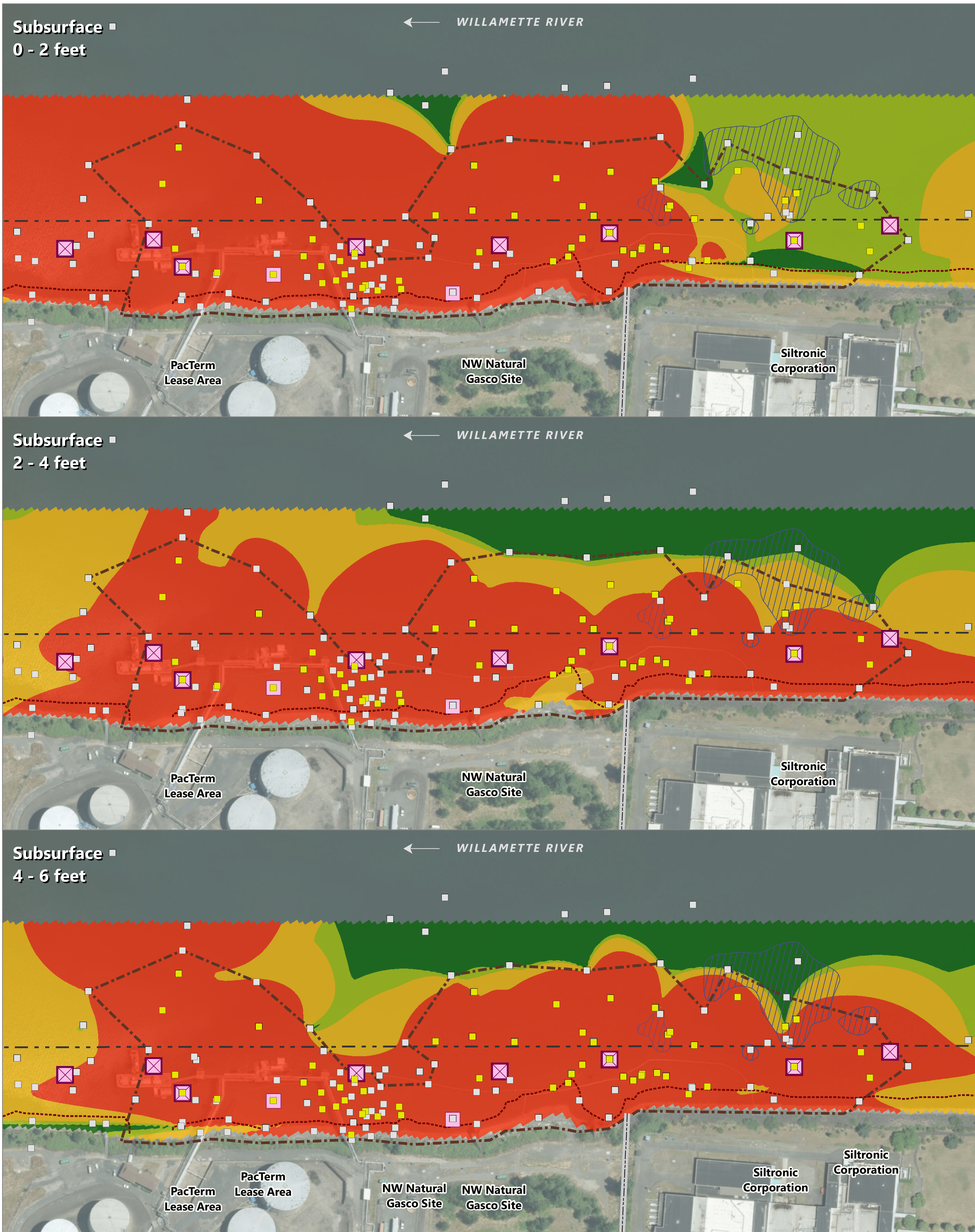
ANCHOR QEA

Figure F-2c

Proposed Paired Subsurface Sediment and Porewater Sampling Locations, Vinyl Chloride in Porewater From 0 to 6 Feet

Supporting Figures for Paired Subsurface Sediment and Porewater and Biogas Generation Potential Locations
Gasco Sediments Cleanup Action



LEGEND:

- Navigation Channel
- Property Line
- Approximate Riprap Boundary[1]
- PTW-NAPL Boundary
- 2010 Transition Zone Water Vinyl Chloride Area 1 Boundary (Anchor QEA 2012)[2]
- Area 2 – Detected CVOCs in TZW and One Subsurface Sediment Location[3]
- Existing Cores with Previously Observed PTW-NAPL
- Existing Cores without Observed PTW-NAPL

Proposed Biogas Generation Potential Sampling Locations

- 6-8 ft Interval
- 5-7 ft Interval

Total PAH (μg/kg)[7]

- < 13,000
- 13,001 - 30,000
- 30,001 - 170,000
- > 170,000

NOTES:

1. Estimated from side scan sonar survey conducted by Blue Water Engineering April 2011.
2. Boundary taken from Draft Engineering Evaluation/Cost Analysis, Appendix A, Figure 4.2. Transition zone water screening level exceedances of cis-1,2-dichloroethene identified within this vinyl chloride boundary.
3. Boundary taken from Gasco Sediments Site Statement of Work, Figure 1 (EPA 2009).
4. Potentially deeper samples will be collected if PTW-NAPL is identified. NAPL mobility testing may be conducted based on PTW-NAPL observations in deeper intervals.
5. The nearshore core locations may need to be adjusted further offshore depending on the river elevations during sample collection to facilitate vessel access.
6. Sediment data obtained from the EPA ROD database, Pre-RD Group 2018 sampling, and NW Natural database.
7. Arrow indicates direction of flow of river.
8. Horizontal datum is NAD83 (HARN 91) Oregon State Plane North, International Feet.
9. Vertical datum is City of Portland (COP), Feet.
10. Aerial imagery from City of Portland 2016.

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Feet

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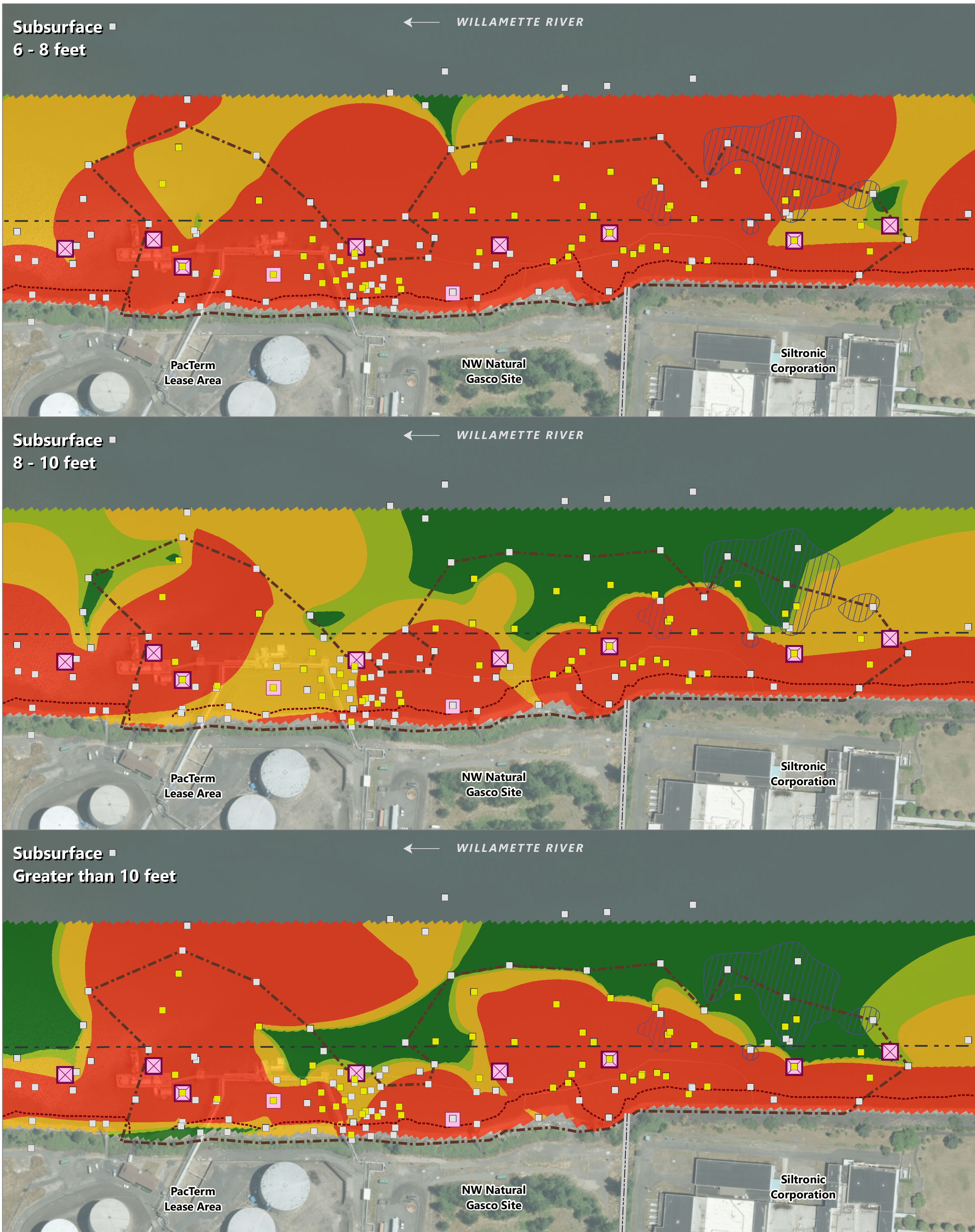
ANCHOR QEA

Figure F-3a

Proposed Biogas Generation Potential Sampling Locations, Total PAH in Sediment From 0 to 6 Feet

Supporting Figures for Paired Subsurface Sediment and Porewater and Biogas Generation Potential Locations
Gasco Sediments Cleanup Action



LEGEND:

- Navigation Channel
- Property Line
- Approximate Riprap Boundary[1]
- PTW-NAPL Boundary
- 2010 Transition Zone Water Vinyl Chloride Area 1 Boundary (Anchor QEA 2012)[2]
- Area 2 – Detected CVOCs in TZW and One Subsurface Sediment Location[3]
- Existing Cores with Previously Observed PTW-NAPL
- Existing Cores without Observed PTW-NAPL

Proposed Biogas Generation Potential Sampling Locations

- 6-8 ft Interval
- 5-7 ft Interval

Total PAH (µg/kg)[7]

- < 13,000
- 13,001 - 30,000
- 30,001 - 170,000
- > 170,000

NOTES:
1. Estimated from side scan sonar survey conducted by Blue Water Engineering April 2011.
2. Boundary taken from Draft Engineering Evaluation/Cost Analysis, Appendix A, Figure 4.2. Transition zone water screening level exceedances of cis-1,2-dichloroethene identified within this vinyl chloride boundary.
3. Boundary taken from Gasco Sediments Site Statement of Work, Figure 1 (EPA 2009).
4. Potentially deeper samples will be collected if PTW-NAPL is identified. NAPL mobility testing may be conducted based on PTW-NAPL observations in deeper intervals.
5. The nearshore core locations may need to be adjusted further offshore depending on the river elevations during sample collection to facilitate vessel access.
6. Sediment data obtained from the EPA ROD database, Pre-RD Group 2018 sampling, and NW Natural database.
7. Arrow indicates direction of flow of river.
8. Horizontal datum is NAD83 (HARN 91) Oregon State Plane North, International Feet.
9. Vertical datum is City of Portland (COP), Feet.
10. Aerial imagery from City of Portland 2016.

0 250
Feet

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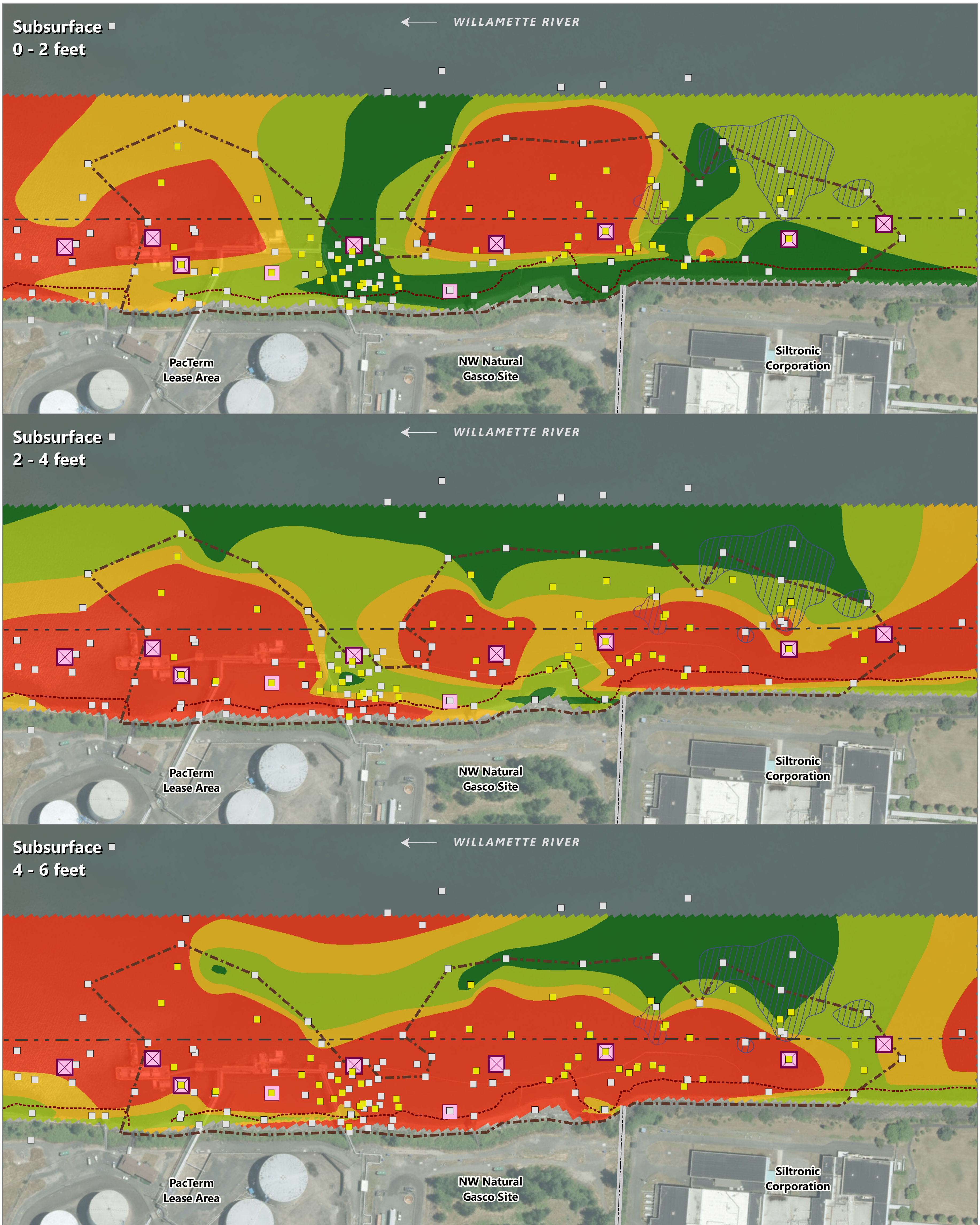
ANCHOR QEA

Figure F-3b
Proposed Biogas Generation Potential Sampling Locations, Total PAH in Sediment From 6 to >10 Feet
Supporting Figures for Paired Subsurface Sediment and Porewater and Biogas Generation Potential Locations
Gasco Sediments Cleanup Action



LEGEND:

- Navigation Channel
- Property Line
- Approximate Riprap Boundary[1]
- PTW-NAPL Boundary
- 2010 Transition Zone Water Vinyl Chloride Area 1 Boundary (Anchor QEA 2012)[2]
- Area 2 – Detected CVOCs in TZW and One Subsurface Sediment Location[3]
- Existing Cores with Previously Observed PTW-NAPL
- Existing Cores without Observed PTW-NAPL

Proposed Biogas Generation Potential Sampling Locations

- 6-8 ft Interval
- 5-7 ft Interval

Total Organic Carbon (%)[7]

- 0.0 - 0.6
- 0.7 - 1.6
- 1.7 - 2.3
- > 2.3

NOTES:
1. Estimated from side scan sonar survey conducted by Blue Water Engineering April 2011.
2. Boundary taken from Draft Engineering Evaluation/Cost Analysis, Appendix A, Figure 4.2. Transition zone water screening level exceedances of cis-1,2-dichloroethene identified within this vinyl chloride boundary.
3. Boundary taken from Gasco Sediments Site Statement of Work, Figure 1 (EPA 2009).
4. Potentially deeper samples will be collected if PTW-NAPL is identified. NAPL mobility testing may be conducted based on PTW-NAPL observations in deeper intervals.
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8. Horizontal datum is NAD83 (HARN 91) Oregon State Plane North, International Feet.
9. Vertical datum is City of Portland (COP), Feet.
10. Aerial imagery from City of Portland 2016.

0 250
Feet

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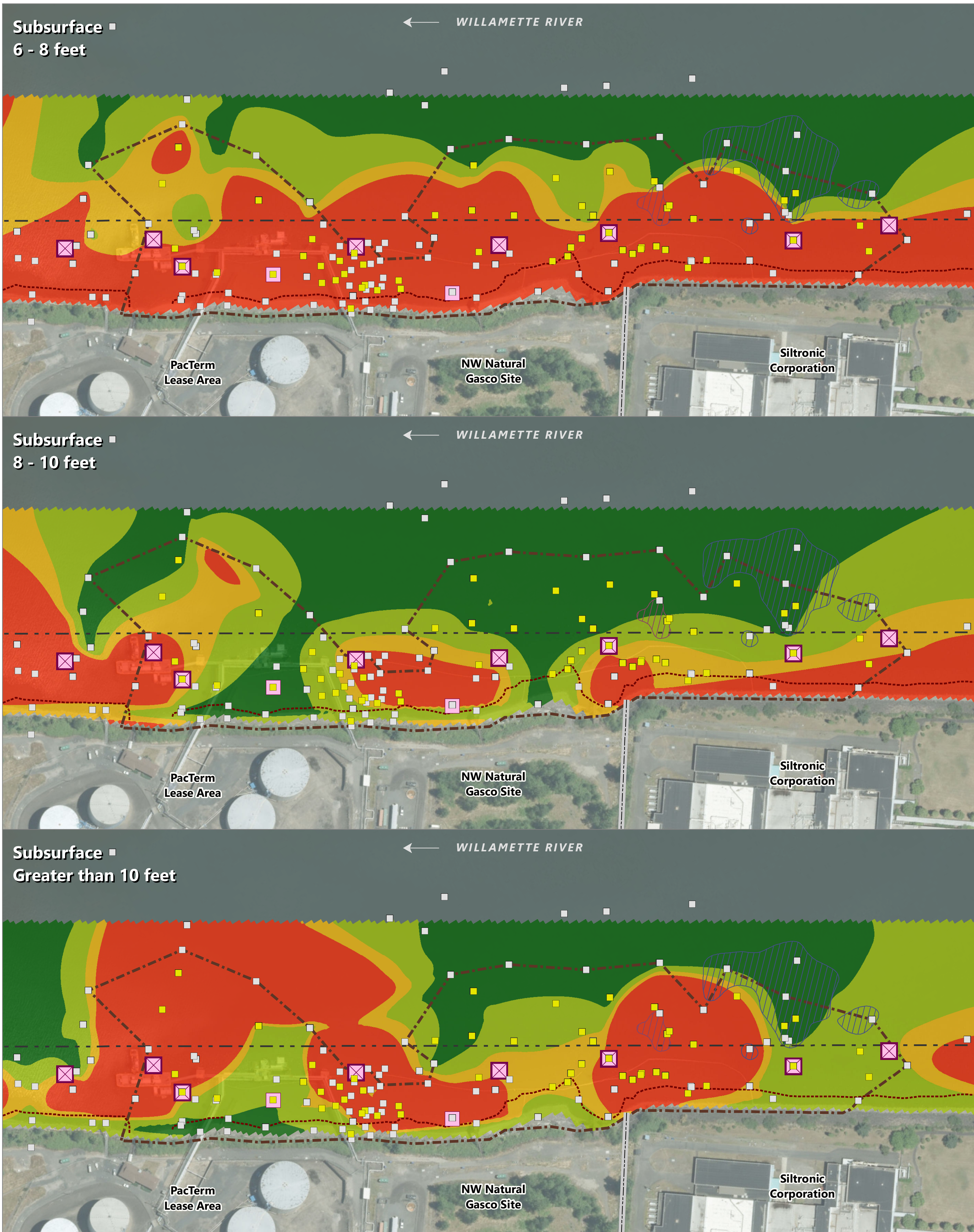
ANCHOR QEA

Figure F-3c
Proposed BiogasGeneration Potential Sampling Locations, TOC in Sediment From 0 to 6 Feet
Supporting Figures for Paired Subsurface Sediment and Porewater and Biogas Generation Potential Locations
Gasco Sediments Cleanup Action



LEGEND:

- Navigation Channel
- Property Line
- Approximate Riprap Boundary[1]
- PTW-NAPL Boundary
- 2010 Transition Zone Water Vinyl Chloride Area 1 Boundary (Anchor QEA 2012)[2]
- Area 2 – Detected CVOCs in TZW and One Subsurface Sediment Location[3]
- Existing Cores with Previously Observed PTW-NAPL
- Existing Cores without Observed PTW-NAPL

Proposed Biogas Generation Potential Sampling Locations

- 6-8 ft Interval
- 5-7 ft Interval

Total Organic Carbon (%)[7]

- 0.0 - 0.6
- 0.7 - 1.6
- 1.7 - 2.3
- > 2.3

NOTES:

1. Estimated from side scan sonar survey conducted by Blue Water Engineering April 2011.
2. Boundary taken from Draft Engineering Evaluation/Cost Analysis, Appendix A, Figure 4.2. Transition zone water screening level exceedances of cis-1,2-dichloroethene identified within this vinyl chloride boundary.
3. Boundary taken from Gasco Sediments Site Statement of Work, Figure 1 (EPA 2009).
4. Potentially deeper samples will be collected if PTW-NAPL is identified. NAPL mobility testing may be conducted based on PTW-NAPL observations in deeper intervals.
5. The nearshore core locations may need to be adjusted further offshore depending on the river elevations during sample collection to facilitate vessel access.
6. Sediment data obtained from the EPA ROD database, Pre-RD Group 2018 sampling, and NW Natural database.
7. Arrow indicates direction of flow of river.
8. Horizontal datum is NAD83 (HARN 91) Oregon State Plane North, International Feet.
9. Vertical datum is City of Portland (COP), Feet.
10. Aerial imagery from City of Portland 2016.

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Feet

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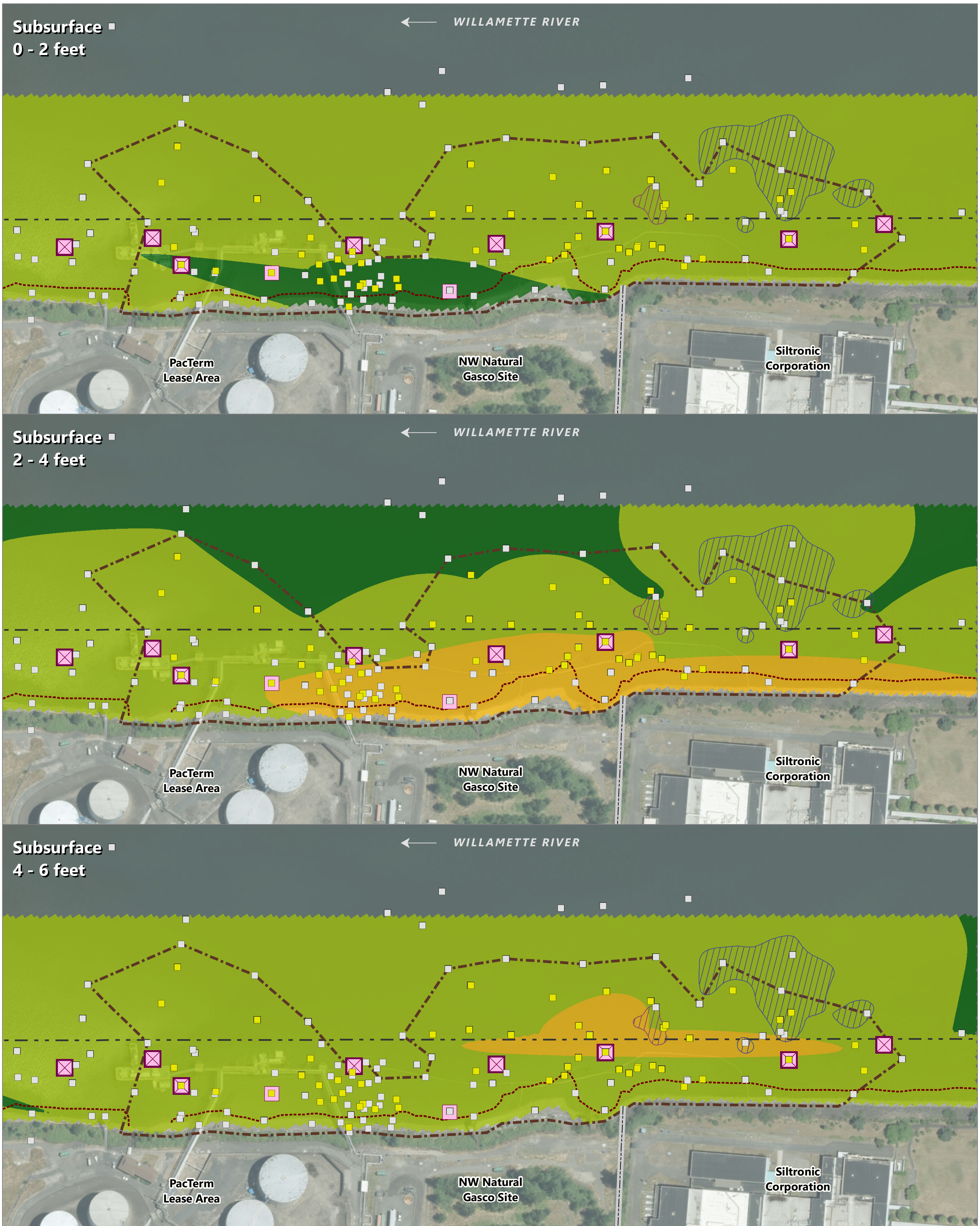
ANCHOR QEA

Figure F-3d

Proposed Biogas Generation Potential Sampling Locations, TOC in Sediment From 6 to >10 Feet

Supporting Figures for Paired Subsurface Sediment and Porewater and Biogas Generation Potential Locations
Gasco Sediments Cleanup Action



LEGEND:

- Navigation Channel
- Property Line
- Approximate Riprap Boundary[1]
- PTW-NAPL Boundary
- 2010 Transition Zone Water Vinyl Chloride Area 1 Boundary (Anchor QEA 2012)[2]
- Area 2 – Detected CVOCs in TZW and One Subsurface Sediment Location[3]
- Existing Cores with Previously Observed PTW-NAPL
- Existing Cores without Observed PTW-NAPL

Proposed Biogas Generation Potential Sampling Locations

- 6-8 ft Interval
- 5-7 ft Interval

Total Gasoline and Diesel Range Hydrocarbons (mg/kg)[7]

- < 845
- 846 - 12,200
- 12,201 - 65,100
- > 65,100

NOTES:

1. Estimated from side scan sonar survey conducted by Blue Water Engineering April 2011.
2. Boundary taken from Draft Engineering Evaluation/Cost Analysis, Appendix A, Figure 4.2. Transition zone water screening level exceedances of cis-1,2-dichloroethene identified within this vinyl chloride boundary.
3. Boundary taken from Gasco Sediments Site Statement of Work, Figure 1 (EPA 2009).
4. Potentially deeper samples will be collected if PTW-NAPL is identified. NAPL mobility testing may be conducted based on PTW-NAPL observations in deeper intervals.
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8. Horizontal datum is NAD83 (HARN 91) Oregon State Plane North, International Feet.
9. Vertical datum is City of Portland (COP), Feet.
10. Aerial imagery from City of Portland 2016.

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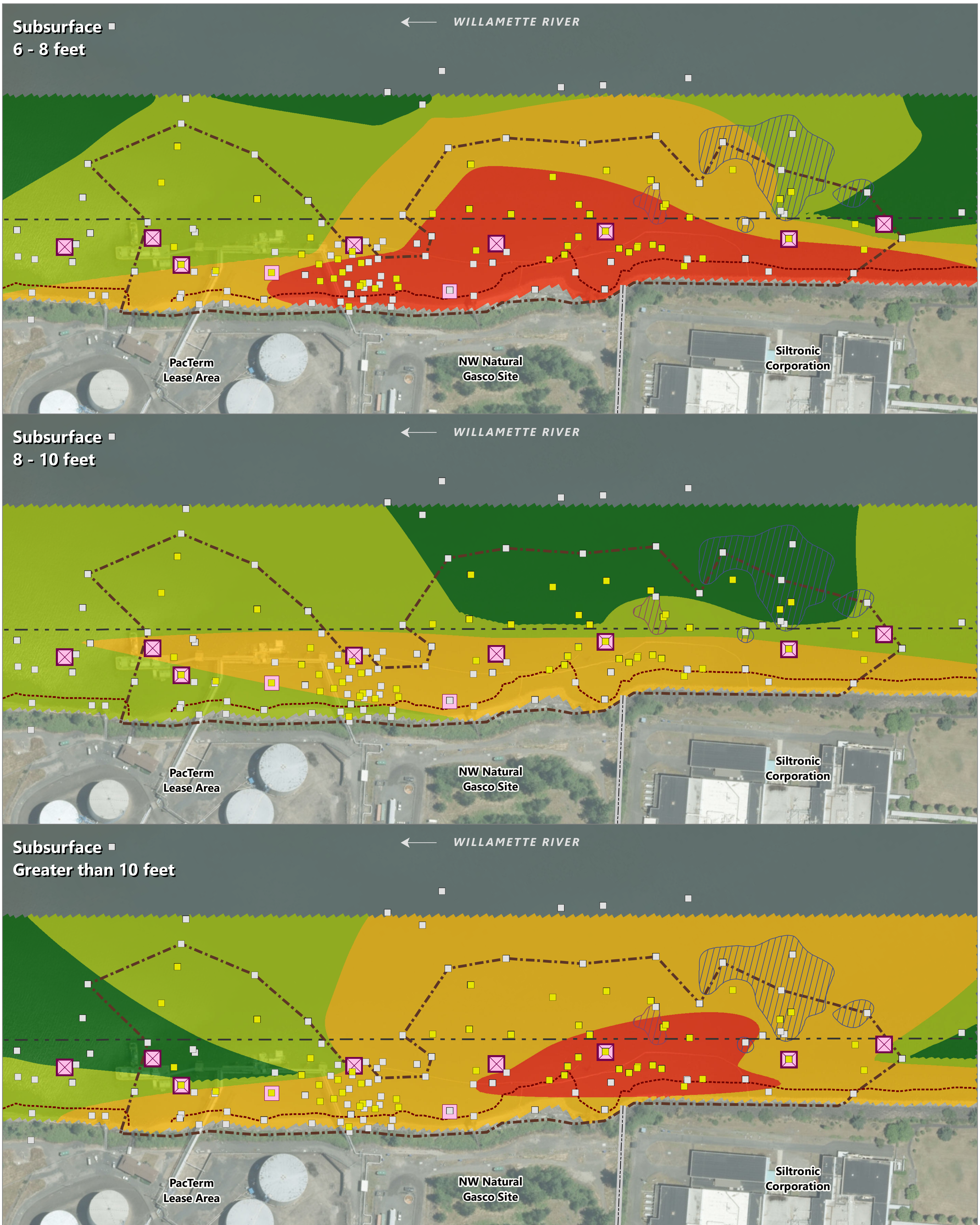
ANCHOR QEA

Figure F-3e

Proposed Biogas Generation Potential Sampling Locations, TPH in Sediment From 0 to 6 Feet

Supporting Figures for Paired Subsurface Sediment and Porewater and Biogas Generation Potential Locations
Gasco Sediments Cleanup Action



LEGEND:

- Navigation Channel
- Property Line
- Approximate Riprap Boundary[1]
- PTW-NAPL Boundary
- 2010 Transition Zone Water Vinyl Chloride Area 1 Boundary (Anchor QEA 2012)[2]
- Area 2 – Detected CVOCs in TZW and One Subsurface Sediment Location[3]
- Existing Cores with Previously Observed PTW-NAPL
- Existing Cores without Observed PTW-NAPL

Proposed Biogas Generation Potential Sampling Locations

- 6-8 ft Interval
- 5-7 ft Interval

Total Gasoline and Diesel Range Hydrocarbons (mg/kg)[7]

- < 845
- 846 - 12,200
- 12,201 - 65,100
- > 65,100

NOTES:

1. Estimated from side scan sonar survey conducted by Blue Water Engineering April 2011.
2. Boundary taken from Draft Engineering Evaluation/Cost Analysis, Appendix A, Figure 4.2. Transition zone water screening level exceedances of cis-1,2-dichloroethene identified within this vinyl chloride boundary.
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9. Vertical datum is City of Portland (COP), Feet.
10. Aerial imagery from City of Portland 2016.

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ANCHOR QEA

Figure F-3f
Proposed Biogas Generation Potential Sampling Locations, TPH in Sediment From 6 to >10 Feet
Supporting Figures for Paired Subsurface Sediment and Porewater and Biogas Generation Potential Locations
Gasco Sediments Cleanup Action

Appendix G
Memorandum Regarding: “Summary of Final Cap Modeling and Long-Term Cap Monitoring Approach – Gasco Sediments Site”

6720 SW Macadam Avenue, Suite 125
Portland, Oregon 97219
503.670.1108

ANCHOR QEA

Memorandum

June 25, 2019

To: Sean Sheldrake and Karl Gustavson, U.S. Environmental Protection Agency

From: Ryan Barth, PE, Anchor QEA, LLC

cc: Bob Wyatt, NW Natural
Patty Dost, Pearl Legal Group
Lance Peterson, CDM Smith
Dana Bayuk, Oregon Department of Environmental Quality
Paul Schroeder, U.S. Army Corps of Engineers
Myron Burr, Siltronic Corporation
Michael Murray, Maul Foster & Alongi

Re: Summary of Final Cap Modeling and Long-Term Cap Monitoring Approach – Gasco Sediments Site

NW Natural and the U.S. Environmental Protection Agency (EPA) continue to expeditiously work toward resolving remaining outstanding technical issues associated with EPA's comments dated March 11, 2019, on the *Revised Pre-Remedial Basis of Design Technical Evaluations Work Plan* (TEWP) dated December 21, 2018. Our mutual goal has been to resolve these issues as soon as possible to facilitate completion of pre-remedial design investigation (PDI) data gaps sampling at the Gasco Sediments Site in the fall 2019 (September through mid-November) to prevent significant project delays. As of last week, the last remaining technical issues pending resolutions regarded the cap modeling and long-term cap monitoring approach to be used at the Gasco Sediments Site. EPA submitted their proposed approach to NW Natural in the *Point of Compliance and Monitoring for Caps in the Portland Harbor Superfund Site* received on May 9, 2019. NW Natural provided comments on this approach in the "NW Natural Response to EPA Comments on NW Natural's Proposed Modeling and Long-term Monitoring for Sediment Caps – Gasco Sediments Site" memorandum, dated May 17, 2019. EPA responded to NW Natural's comments in a document dated June 9, 2019.

NW Natural and EPA attended a meeting on June 13, 2019, to discuss EPA's June 9, 2019 response to comments letter and successfully resolved the remaining outstanding issues. This memorandum summarizes these resolutions. Please note that these resolutions do not impact the *Final Revised Pre-Remedial Basis of Design Technical Evaluation Work Plan* or *Pre-Remedial Design Data Gaps Work Plan* (DGWP) submitted to EPA on June 10, 2019, so those documents require no revisions. The resolutions will be incorporated into the forthcoming *Pre-Remedial Design Basis of Design Report* and subsequent remedial design documents.

We are pleased to have resolved the remainder of the technical issues on the TEWP and look forward to expeditiously resolving any comments on the DGWP, so we can initiate the data gaps sampling in early September 2019.

Point of Compliance

During the meeting held between NW Natural and EPA on June 13, 2019, it was decided that the most appropriate point of compliance for monitoring long-term cap performance at the Gasco Sediments Site is directly above the chemical isolation layer where any contaminant breakthrough would first be encountered. This point of compliance will be consistently applied throughout the entire cap footprint, regardless of overlying sediment depositional and erosional characteristics encountered during the long-term monitoring period. EPA and NW Natural have agreed that, at the Gasco Sediment Site, this point of compliance will eliminate EPA's concern of rapid surface and porewater exchange in the overlying erosion resistance layer and minimize data interpretation issues associated with variable measurement depths over time.

Both EPA and NW Natural agreed that the final resolution provides a superior site-specific approach to monitoring that provides the added advantage of repeatability and data consistency.

Long-Term Cap Monitoring Sampling Approach

NW Natural will perform long-term cap monitoring at the point of compliance through the installation of monitoring ports during cap material placement and collection of porewater in the ports via passive samplers. Ports will be installed and used both for consistent data repeatability and because passive samplers cannot be feasibly installed through an erosion resistance layer and underlying geotechnical filter layer. A schematic of the proposed monitoring port is shown in Attachment A, Figure 1. The port is constructed of a reinforced concrete manhole/culvert that is approximately 4 feet high by 4 feet wide. This monitoring port design was recently installed at the River Raisin Area of Concern Superfund Site cleanup in Michigan with successful post-construction porewater monitoring. As shown in Attachment A, Figure 1, the monitoring port will be placed on top of the chemical isolation layer following confirmation the chemical isolation layer design thickness has been achieved. Prior to installation, a stainless-steel screen will be affixed to the bottom of the monitoring port to prevent the inadvertent penetration of the passive sampler (performed by divers) into the underlying chemical isolation layer. The interior space of the monitoring port will be filled with a uniformly graded material containing a hydraulic conductivity equal to or greater than the geotechnical filter layer. This will create a preferential pathway for porewater advection into and through the monitoring port and provide a conservative measurement of the porewater concentrations exiting the chemical isolation layer outside the sampling port. As noted in Attachment A, Figure 1, the specific porewater sampling depth interval extending immediately above the chemical isolation layer will be determined based on the sampling method (e.g., solid phase microextraction, polyethylene diffusion bags, regenerated cellulose dialysis membrane) volume requirements for the target chemical analyses.

The long-term cap chemical isolation performance will be assessed via comparison of the measured porewater concentrations against the Record of Decision (ROD) Table 17 groundwater cleanup levels. NW Natural agrees to perform porewater monitoring expeditiously following remedy completion (Time 0 sampling) for the full ROD Table 17 chemicals with groundwater cleanup levels. NW Natural proposes subsequent monitoring be focused solely on the highest mobility contaminants (i.e., benzene and naphthalene) during years 1, 3, and 5 and all subsequent 5-year monitoring events, as well as analysis of the full ROD Table 17 chemicals with groundwater cleanup levels during each 5-year monitoring event at 10% of the total sampling locations. NW Natural will conservatively perform each of the cap monitoring events during the summer months when the groundwater elevations are highest relative to the river elevations, creating the highest hydraulic head for porewater migration into the monitoring ports. During each monitoring event, the passive sampler will be deployed for approximately 30 days to facilitate equilibration of the sediment porewater with the passive sampling media. For hydrophobic organic compounds (e.g., polycyclic aromatic hydrocarbons [PAHs]), full equilibrium is not likely to be achieved, so performance reference compounds will be analyzed to correct for non-equilibrium in the measured concentrations.

During remedial design, NW Natural will determine the density of monitoring ports that will provide representative results for determining the effectiveness of the remedy consistent with the ROD. For example, if capping were chosen to be the remedial technology throughout the Interim Project Area, NW Natural would propose the installation of a total of 10 permanent porewater sampling monitoring access ports in the shallow and intermediate regions and 7 permanent access ports in the navigation channel/future maintenance dredge areas. This would result in a sampling density of approximately one permanent sampling access port per acre of capping. The locations of the permanent sample ports in each of the depth zones would be determined during remedial design based on the site characteristics (e.g., subsurface sediment concentrations, seepage flux rates, sediment physical characteristics, and the presence of Siltronic-related chlorinated solvent byproduct concentrations) in the cap areas.

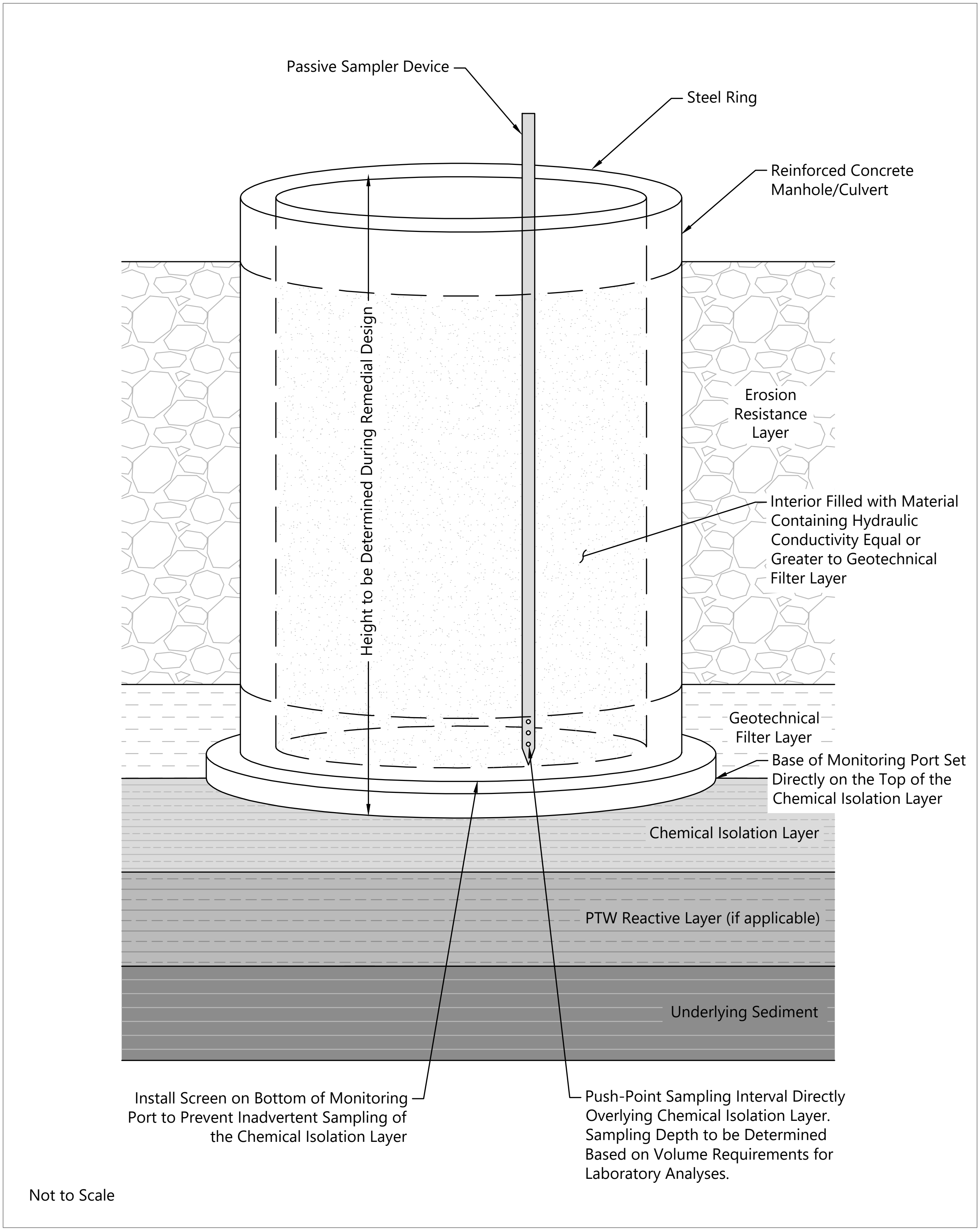
Concurrent with the long-term cap chemical isolation monitoring events, NW Natural will also perform cap physical monitoring via bathymetry surveys to verify the presence and stability of the armor layer. The as-built elevations will establish baseline post-construction conditions for comparison to long-term bathymetry elevation surveys. In addition, consistent with Section 14.2.7 of the ROD, physical inspections will also be required after natural events that exceed a specified magnitude, such as earthquakes or floods, and manmade events, such as boat collisions or violations of land use restrictions (e.g., vessel grounding, anchoring in a regulated navigation area).

A detailed description of the chemical and physical monitoring activities during each monitoring event, along with associated response actions, will be provided in the future *Long-Term Maintenance and Monitoring Plan*.

Interim-Construction Cap Placement Verification

NW Natural will collect mid-construction cores, in addition to other lines of evidence (e.g., bathymetry and cap material placement quantity tracking) to field-verify that the design thickness for the chemical isolation layer is achieved. These cores will only be visually assessed for chemical isolation layer thickness. No other physical or chemical analyses will be performed on these cores. These cores will be collected at a tiered frequency, with a higher frequency of cores collected during the initial cap construction activities followed by a reduced frequency as construction progresses if the initial cores identify the design thicknesses are consistently achieved.

Attachment A



ANCHOR QEA

Figure 1
Long-Term Cap Monitoring Sampling Port Schematic
Gasco Sediments Cleanup Action

Appendix H
Updated Pre-RD Data Gaps Sampling Technical Briefing – Gasco Sediments Site

Updated Pre-RD Data Gaps Sampling Technical Briefing – Gasco Sediments Site

Presented by

NW Natural and Anchor QEA

June 26, 2019

Technical Briefing Agenda

- Introduction and purpose
- Path forward and schedule
- Overview of updated pre-remedial design investigation
- Surface sediment data collection
- Subsurface sediment data collection

Introduction and Purpose

- NW Natural provided a Gasco Sediments Site data gaps technical briefing on November 27, 2018, to solicit early feedback from EPA.
- NW Natural incorporated all feedback received from EPA in the *Pre-Remedial Design Data Gaps Work Plan* (Data Gaps Work Plan), submitted to EPA on June 10, 2019. The Data Gaps Work Plan is intended to fill the identified data gaps necessary to complete remedial design for a final remedy at the Gasco Sediments Site.
- This briefing summarizes the updated proposed data gaps sampling to expedite EPA's review of the Data Gaps Work Plan and facilitate field sampling in September 2019. NW Natural is seeking approval by August 30, 2019, to meet the proposed field schedule.

Path Forward and Schedule

Path Forward and Schedule

- EPA to review the Data Gaps Work Plan and provide comments to NW Natural
  - EPA review and comment period of 45 days (July 25)
  - 36-day period during which NW Natural and EPA collaborate to resolve remaining outstanding issues (August 30)
- NW Natural to perform comprehensive data gaps sampling
  - Early September to mid-November 2019

Overview of Updated Pre-Remedial Design Investigation

Overview of Surface (0 to 1 Foot) Sediment Program

Program	Data Objectives	Analytes	Number of Stations
Interim Project Area Refinement	SMA delineation	ROD Table 21 COCs with RALs and PTW-highly toxic thresholds	4
	Additional data density	ROD Table 21 COCs with RALs and PTW-highly toxic thresholds	4

Note:
The subsurface sediment program discussed in this presentation includes sampling at surface or near-surface intervals in many locations.

Overview of Subsurface Sediment Program

Program	Data Objectives	Analyses	Number of Stations
Dredging Evaluation	Determine the vertical distribution of contaminants to support dredge design	ROD Table 21 COCs with RALs and PTW-highly toxic thresholds	72
	Refine PTW-NAPL boundary	Visual observations only	16 co-located with DOC cores
Capping Demonstration Evaluations	Bulk sediment concentrations converted to porewater data using site-specific or literature partitioning coefficients	PAHs, ROD Table 17 VOCs with groundwater cleanup levels (CULs), arsenic	87
	Paired bulk sediment and porewater to develop site-specific partitioning coefficients	ROD Table 17 VOCs with groundwater CULs	12 co-located bulk sediment and porewater locations
	Subsurface porewater samples in targeted areas with PTW-NAPL; porewater filtered through ceramic filter to exclude NAPL	PAHs, ROD Table 17 VOCs with groundwater CULs	Up to 5

Overview of Subsurface Sediment Program

Program	Data Objectives	Analyses	Number of Stations
NAPL Mobility	Obtain representative, relatively undisturbed sediment samples for laboratory testing of NAPL mobility	Shake tests, centrifuge, percent water saturation, percent initial and final NAPL saturation, total porosity, grain density, dry bulk density, grain size	Up to 6
Gas Ebullition – Biogas Generation Potential	Model subsurface biogeochemical conditions under post-dredge cap to inform biogas production zones and potential for gas ebullition to transport NAPL under future post-construction conditions	TOC, PAHs (parent and alkyl), TPH, COD, LOC fractions, biogas production potential, moisture content, grain size	10
Gas Ebullition – Mass Flux	Estimate gas ebullition-facilitated NAPL flux	Visual observations and TPH	TBD
Geotechnical Evaluation	Support the site-specific capping demonstrations and dredge prism design	Moisture content, specific gravity, Atterberg limits, gradation, bulk density, 1D compressibility, CU and UU triaxial strength tests	17 borings and 9 in situ test borings

Overview of Subsurface Sediment Program

Program	Data Objectives	Analyses	Number of Stations
Riverbank Boring	Collect additional information to further evaluate the vertical and lateral extents of PTW-NAPL, PTW-highly toxic threshold, and RAL exceedances to support remedial technology evaluations	• ROD Table 21 COCs with RALs and PTW highly toxic thresholds • ROD Table 17 COCs with river bank soil/sediment CULs • ROD Table 17 VOCs with groundwater CULs, PAHs, and arsenic • TOC, TS, bulk density, moisture content, grain size, specific gravity	8
Waste Characterization	Pre-characterize dredging wastes to further inform handling, transport, and disposal classification	Ignitability, corrosivity, VOCs, paint filter, TCLP analyses on bulk sediment and leachates	12
Barge Dewatering	Estimate chemical concentrations of excess water in the dredge material haul barge and support water quality treatment evaluations	Cyanide, metals, PCBs, pesticides, PAHs, SVOCs, VOCs, pH, TSS on standard elutriate sample	12

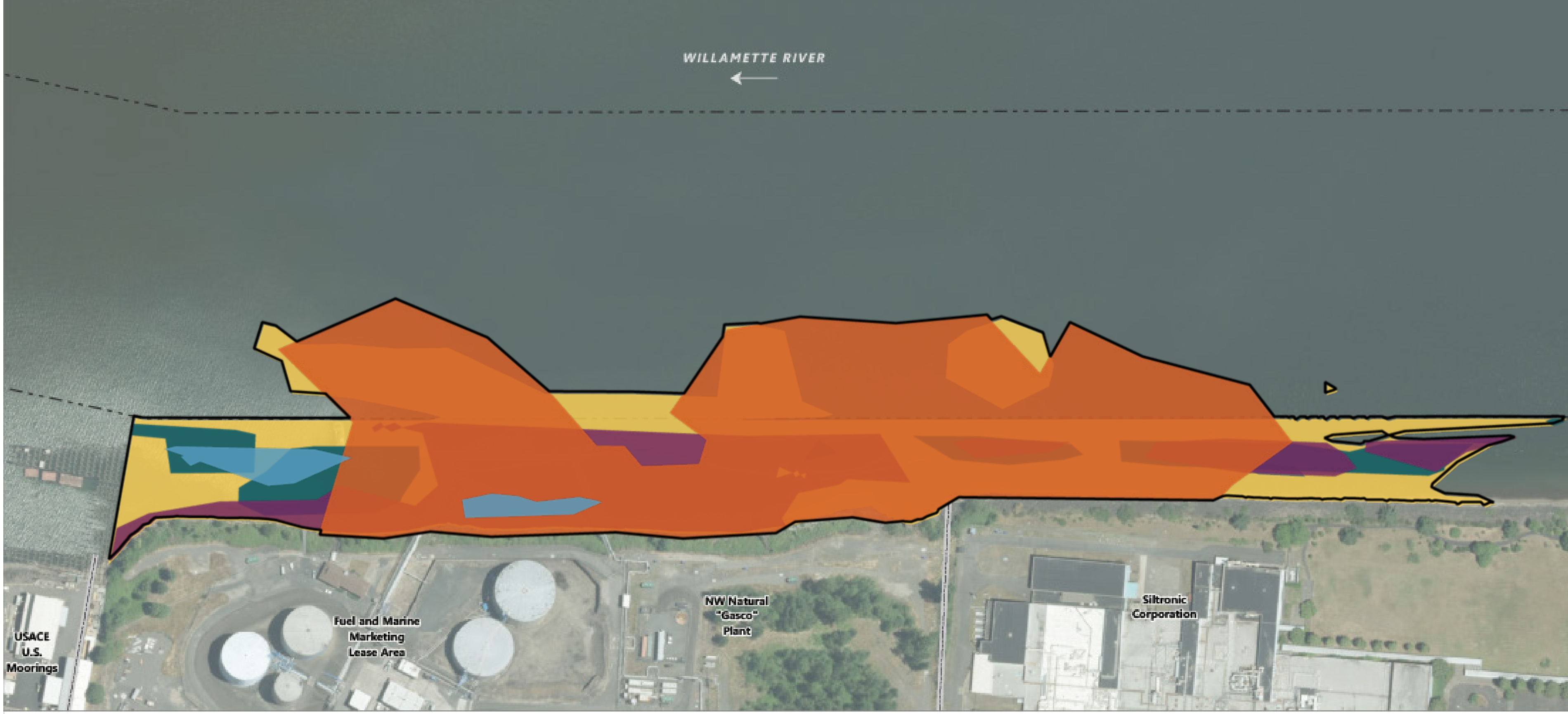
Overview of Subsurface Sediment Program

Program	Data Objectives	Analyses	Number of Stations
Additional Analyses	Provide surface and shallow subsurface sample concentrations for non-manufactured gas plant (MGP) COCs	Non-PAH ROD Table 21 COCs (e.g., PCBs, pesticides, and dioxins/furans)	61
	Characterize the chemical composition of the PTW-NAPL-impacted sediments	Comprehensive hydrocarbon analyses	Up to 6
	Evaluate potential sediment recontamination in the 2005 Gasco Early Action Area due to depositional sediment	• ROD Table 21 RALs and PTW-highly toxic thresholds • ROD Table 17 COCs with river bank soil/sediment CULs	4

Project Area Refinement

Surface Sediment: SMA Delineation

- Objective
  - Use ROD multiple lines of evidence to refine the Gasco Sediments Site Project Area
- Lines of evidence include:
  - Alternative F Modified RALs (with Explanation of Significant Differences [ESD] applied)
  - PTW-NAPL using site-specific definition identified in the Statement of Work – Gasco Sediments Site and adopted in the ROD
  - PTW-highly toxic thresholds (with ESD applied)
- ROD Table 21 PTW-not reliably contained (NRC) thresholds are not included given these thresholds are based on non-site-specific data
  - NW Natural to identify any applicable PTW-NRC thresholds based on site-specific capping demonstration



LEGEND:

- Navigation Channel
- Structures
- Property Line
- ROD-Identified SMAs (EPA 2017) Included in the Gasco Sediment Site Interim Project Area
- Total PAH RAL
- Total PCB RAL
- Total DDx RAL
- D/F RALs
- PTW-NAPL Area
- PTW-Highly Toxic

NOTE(S):

1. Arrow indicates direction of flow of river.
2. Horizontal datum is NAD83 Oregon State Plane North, International Feet.
3. Aerial imagery from City of Portland 2016.
4. All depicted RAL and PTW contours taken from the Portland Harbor Superfund Site Record of Decision (2017).

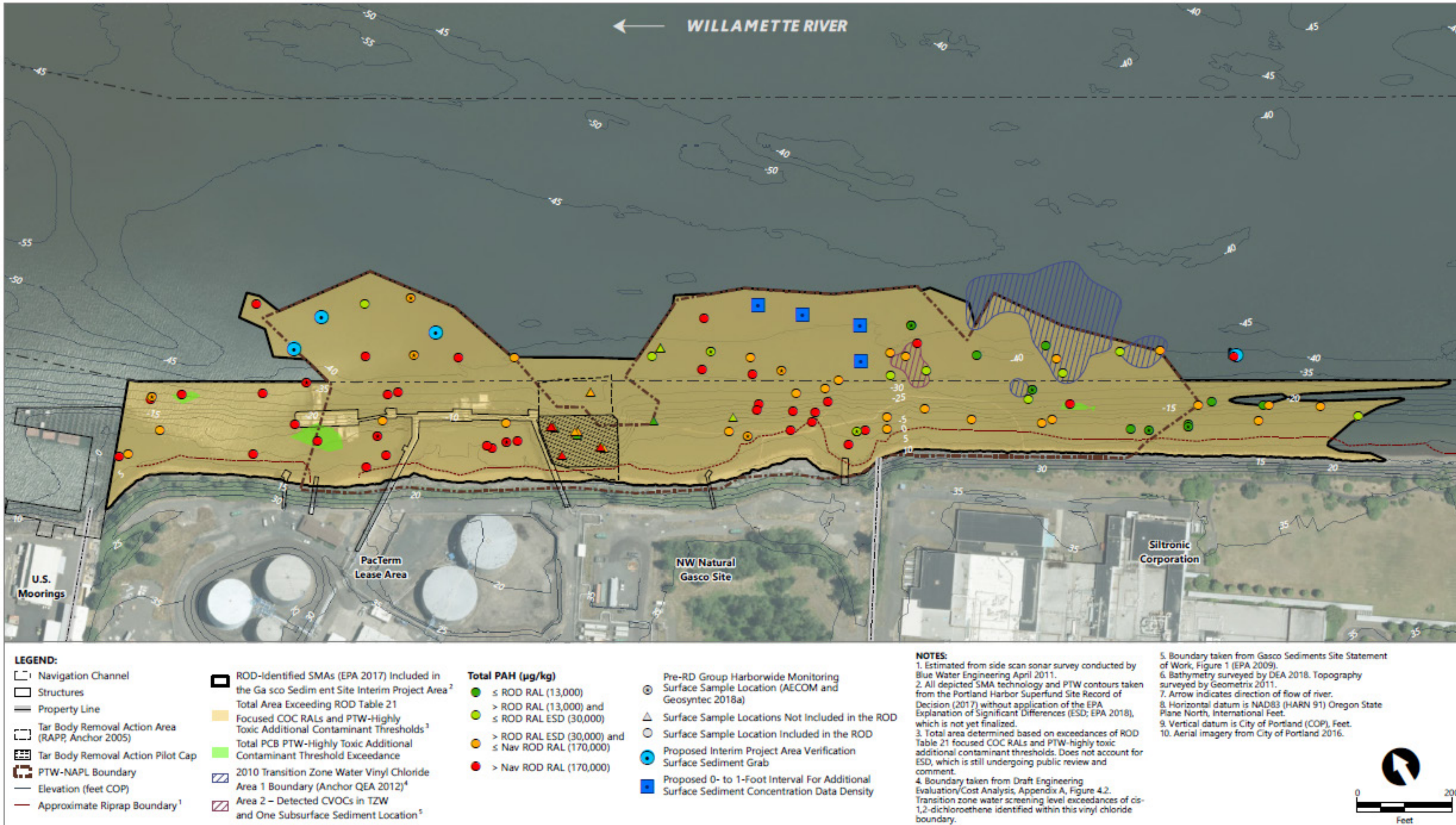
0 200
Feet

Surface Sediment: Gasco Sediments Site Project Area

Surface Sediment: SMA Delineation

- Additional surface sediment density warranted to finalize the channelward extents of the Project Area using RAL exceedance contours, PTW-highly toxic exceedance contours, and PTW-NAPL
- Proposing four surface grabs (0 to 1 foot)
  - Consistent with harborwide baseline sampling program, each sample will consist of a three-point composite
  - ROD Table 21 Focused COCs and PTW-highly toxic thresholds
- Proposing four core locations (0 to 1 foot)
  - Analyzed for additional data density within a portion of the Project Area that is defined by the PTW-NAPL boundary
  - Each sample will consist of a discrete surface sediment interval
  - ROD Table 21 Focused COCs and PTW-highly toxic thresholds

Surface Sediment: SMA Delineation and Recontamination Proposed Sampling Locations



Dredging and PTW-NAPL Refinement Evaluations

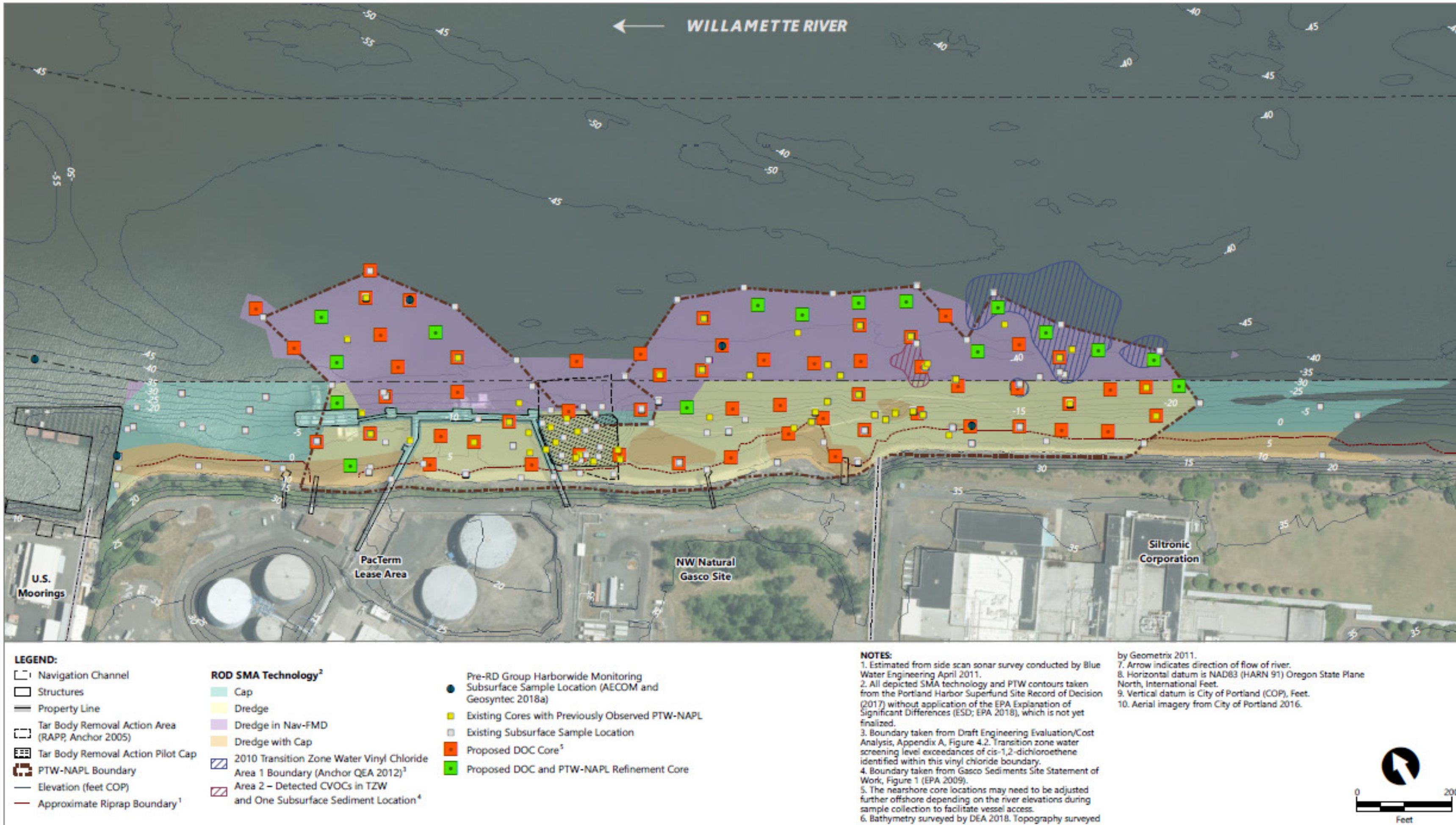
Subsurface Sediment: Dredging Evaluation

- Objective
  - Determine the vertical distribution of contaminants to support dredge design
- DOC unknown at majority of existing subsurface core locations
- Proposing seventy-two 20-foot cores (100- to 150-foot grid spacing)
- Analyze for full ROD Table 21 COCs with RALs and PTW-highly toxic thresholds from the bottom of each core in two successively shallower 1-foot intervals
- DOC defined as upper sampling depth that contains 2 consecutive feet of no RAL and PTW-highly toxic threshold exceedances

Subsurface Sediment: Dredging Evaluation

- The 20-foot cores are expected to bound DOC in most areas, but it is not possible to determine in advance where DOC will not be confirmed
- After the data from the 20-foot cores are evaluated, NW Natural will determine whether additional DOC data are required to support remedial design
- A decision framework is included in the Data Gaps Work Plan to determine what additional data collection is necessary to support remedial design, including criteria for selecting the location/depth of deeper cores
- NW Natural will coordinate with EPA on the collection of limited additional cores for non-remedial design purposes (e.g., contaminant inventory)

Subsurface Sediment: DOC Evaluation Proposed Sampling Locations



Subsurface Sediment: PTW-NAPL Refinement

- Objective
  - Identify full lateral and vertical extents of PTW-NAPL throughout the Project Area
- Refine PTW-NAPL extents based on visual observations performed on DOC cores using site-specific definition

Capping Demonstration Evaluations

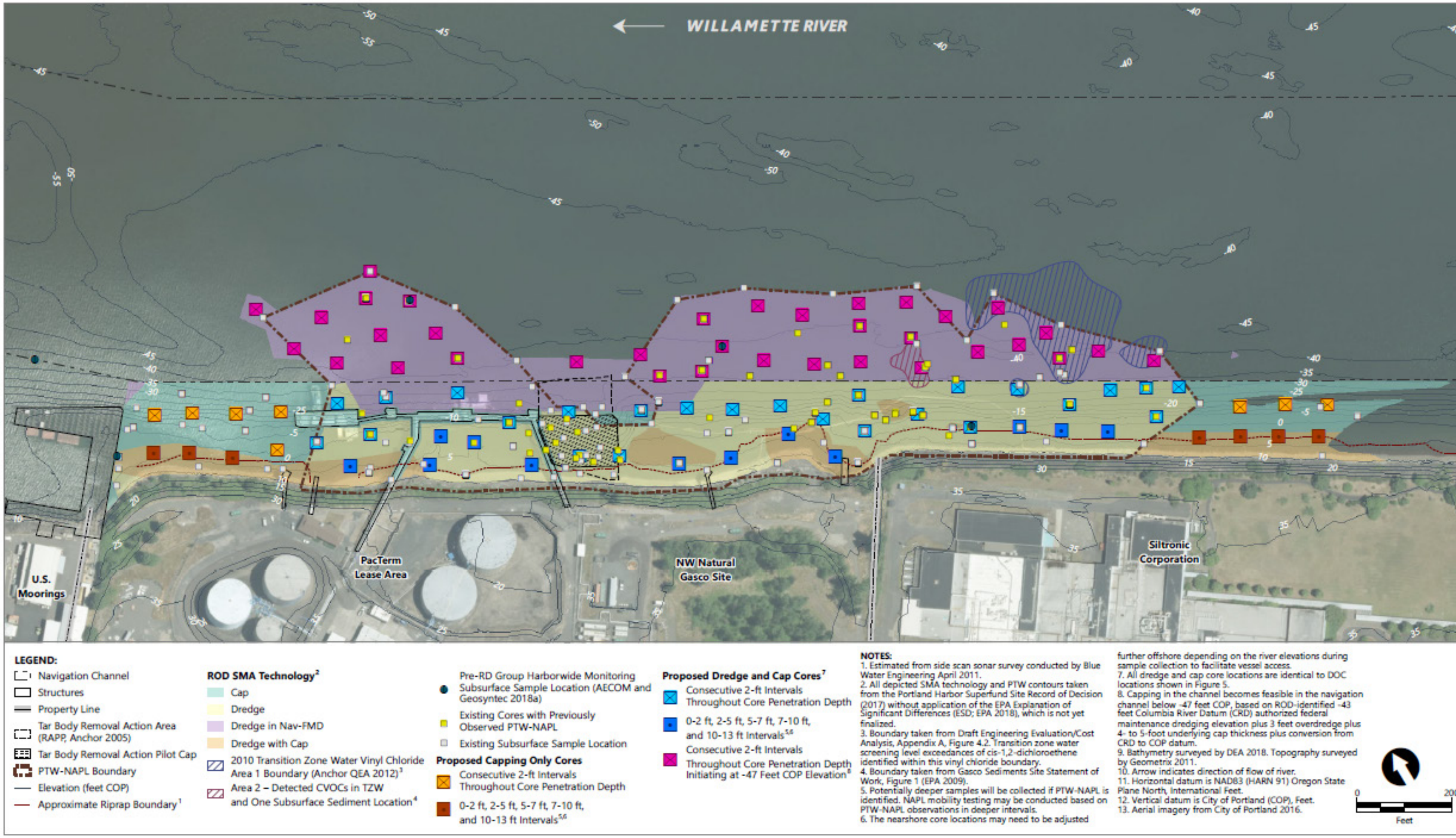
Subsurface Sediment: Cap Modeling in the Navigation Channel

- Objective
  - Collect additional data to support capping demonstration evaluation in the navigation channel
- Proposing thirty-five 20-foot cores throughout ROD-identified cap-only areas
  - Chemical: PAHs (full list of 17 PAHs), VOCs (only those VOCs with a ROD Table 17 groundwater CUL), and arsenic
  - Physical: TOC, TS, moisture content, specific gravity, grain size, and Atterberg Limits
  - Consecutive 2-foot intervals from elevation -47 feet City of Portland (COP) datum (maintenance dredging elevation plus 3-foot buffer) to the full core recovery depth

Subsurface Sediment: Cap Modeling Outside the Navigation Channel

- Objective
  - Collect additional data to support capping demonstration evaluation in the intermediate and shallow regions
  - Convert bulk sediment data to porewater data using site-specific equilibrium partitioning coefficients
- Proposing fifty-two 20-foot cores outside the channel
  - Chemical: PAHs (full list of 17 PAHs), VOCs (only those VOCs with a ROD Table 17 groundwater CUL), and arsenic
  - Physical: TOC, TS, moisture content, specific gravity, grain size, and Atterberg Limits
  - Intermediate region: consecutive 2-foot intervals from the existing mudline to the full core recovery depth
  - Shallow region: 0 to 2 feet, 2 to 5 feet, 5 to 7 feet, 7 to 10 feet, and 10 to 13 feet

Subsurface Sediment: Cap Modeling Proposed Sampling Locations



Paired Subsurface Sediment-Porewater to Develop Equilibrium Partitioning Coefficients for VOCs

- NW Natural collected 12 co-located surface sediment and transition zone water samples in spring 2018 to develop site-specific sediment-porewater equilibrium partitioning coefficients for use in cap modeling
- Results showed non-detected VOC sediment and porewater concentrations, eliminating ability to develop site-specific partition coefficients – no data gaps identified for other COCs with ROD Table 17 groundwater CUL
- Paired subsurface sediment and porewater sampling proposed in target areas with range of previously identified detected subsurface sediment VOC concentrations and no PTW-NAPL (location/interval will be adjusted based on field observations, if necessary)

Paired Subsurface Sediment-Porewater to Develop Equilibrium Partitioning Coefficients for VOCs

- Proposing 12 paired sediment and porewater locations
  - Analyzed for VOCs with ROD Table 17 groundwater CULs
  - The samples will be collected from either the 4- to 6-foot interval (intermediate region) or 5- to 7-foot interval (shallow region)
  - Subsurface porewater samples will be collected from a 2-foot screen interval advanced to the target depth using a Geoprobe drill rig deployed from a vessel
  - A porous ceramic cup will be used to remove any NAPL that may be present in the sample

Subsurface Porewater Samples in Contact with PTW-NAPL

- These samples will be used to characterize porewater PAH and VOC concentrations in contact with PTW-NAPL to define cap model inputs in areas containing PTW-NAPL
- These data will provide a means of defining the upper limits for porewater concentrations calculated using partitioning coefficients from bulk sediment
- Proposing to collect up to five porewater samples from sediments containing a representative range of PTW-NAPL characteristics identified in the field
  - Samples will be collected using porewater methods proposed for paired subsurface sediment and porewater VOC sampling
  - A porous ceramic cup will be used to remove NAPL

Subsurface Sediment: NAPL Mobility Via Advection

- Objective
  - Collect data to evaluate PTW-NAPL mobility via advection
- Proposing to sample PTW-NAPL visually observed in up to 6 DOC core locations
  - Ultraviolet photography, sediment physical properties (e.g., porosity), PTW-NAPL fluid properties (viscosity), and PTW-NAPL pore-scale mobility characteristics (centrifuge testing PTW-NAPL saturation in sediment pore spaces)
  - Locations TBD based on range of observed PTW-NAPL conditions in DOC cores

Subsurface Sediment: Gas Ebullition – Biogas Generation Potential

- Objective
  - Collect data to support/refine methane gas generation modeling
  - Use sediment characteristics and empirical methane production rates as input to biogeochemical reaction-transport model to simulate depth-duration of methane bubble generation under current and future conditions
- Proposing to sample 10 cores
  - Either the 6- to 8-foot interval (intermediate region) or 5- to 7-foot interval (shallow region) will be sampled
  - Locations selected to cover range of TOC and PAH concentrations
  - Analyze for TOC, PAHs (parent and alkyl), TPH, COD, LOC fractions, moisture content, grain size
  - In addition, potential methane production rates will be measured on sediment subsamples in microcosm incubations

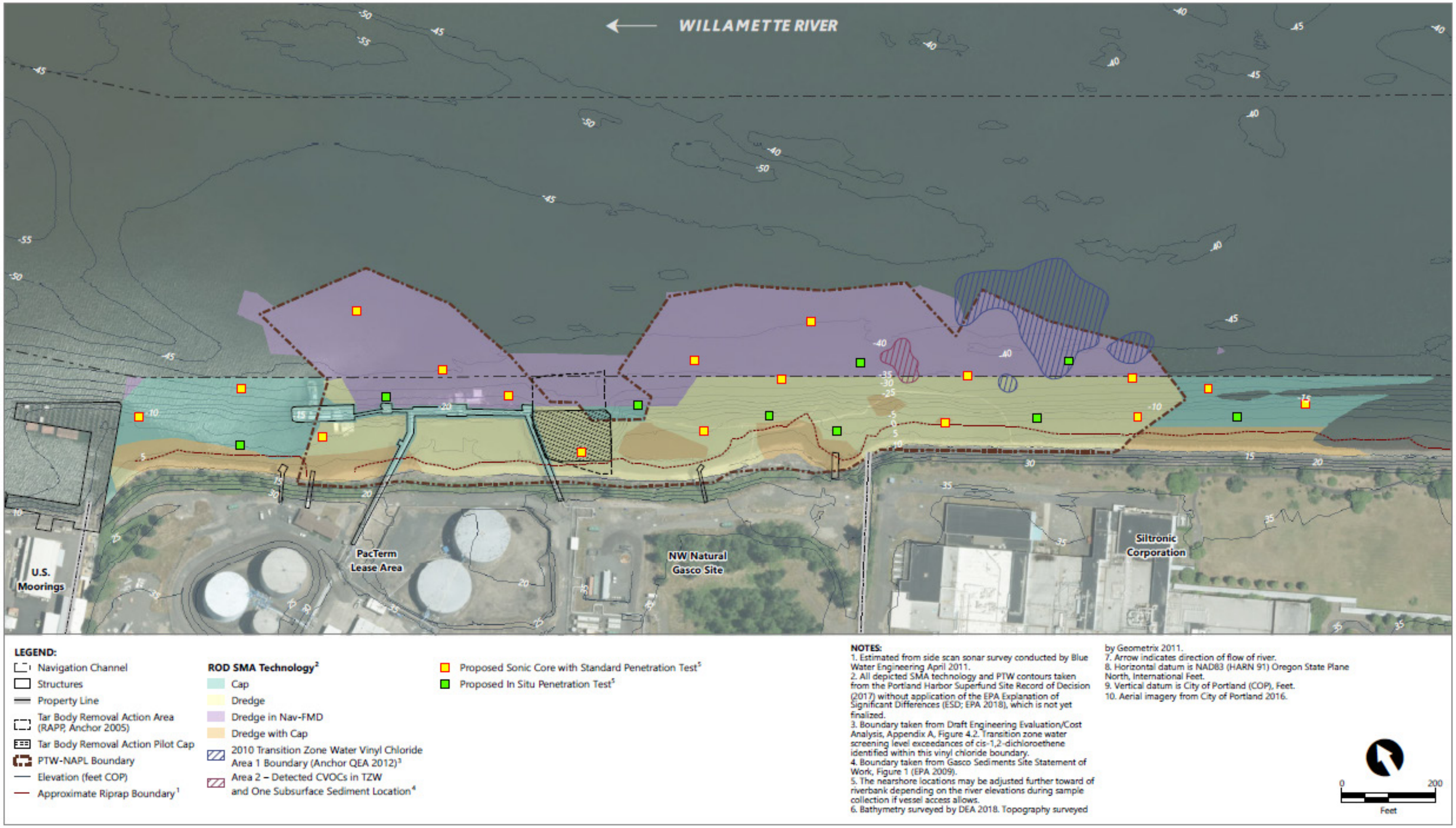
Subsurface Sediment: Gas Ebullition – Mass Flux

- Objective
  - Collect data to support gas ebullition-facilitated PTW-NAPL flux modeling
- Proposing to perform one event with targeted visual observations and surface sheen sampling
  - Target locations TBD based on field visual observations of gas ebullition and surface sheens
  - Observations will include frequency, location, size, and color of sheens; location and size of bubbles
  - Several sheens will be sampled and analyzed for mass and chemical constituents (TPH)

Subsurface Sediment: Geotechnical Evaluation

- Objectives
  - Cap design (stability, settlement, bearing capacity, and consolidation)
  - Dredge design (slope stability of dredge cuts and adjacent structures)
  - Water quality containment barrier design
- Advance seventeen sonic cores with standard penetration tests and nine in situ test borings
  - Moisture content, specific gravity, Atterberg limits, gradation, bulk density, 1D compressibility, CU and UU triaxial strength tests

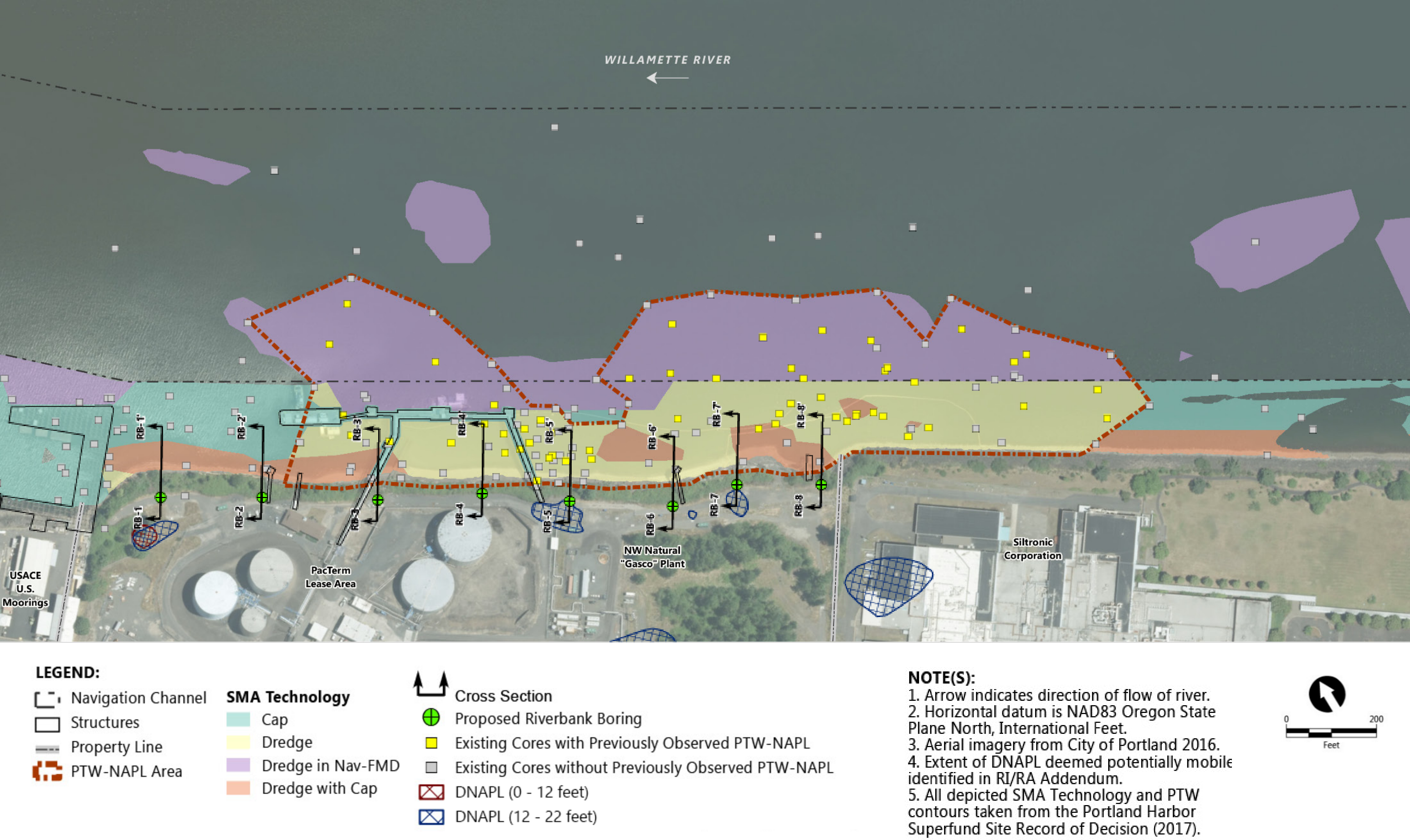
Subsurface Sediment: Geotechnical Evaluation Proposed Sampling Locations



Riverbank Remedy Evaluation

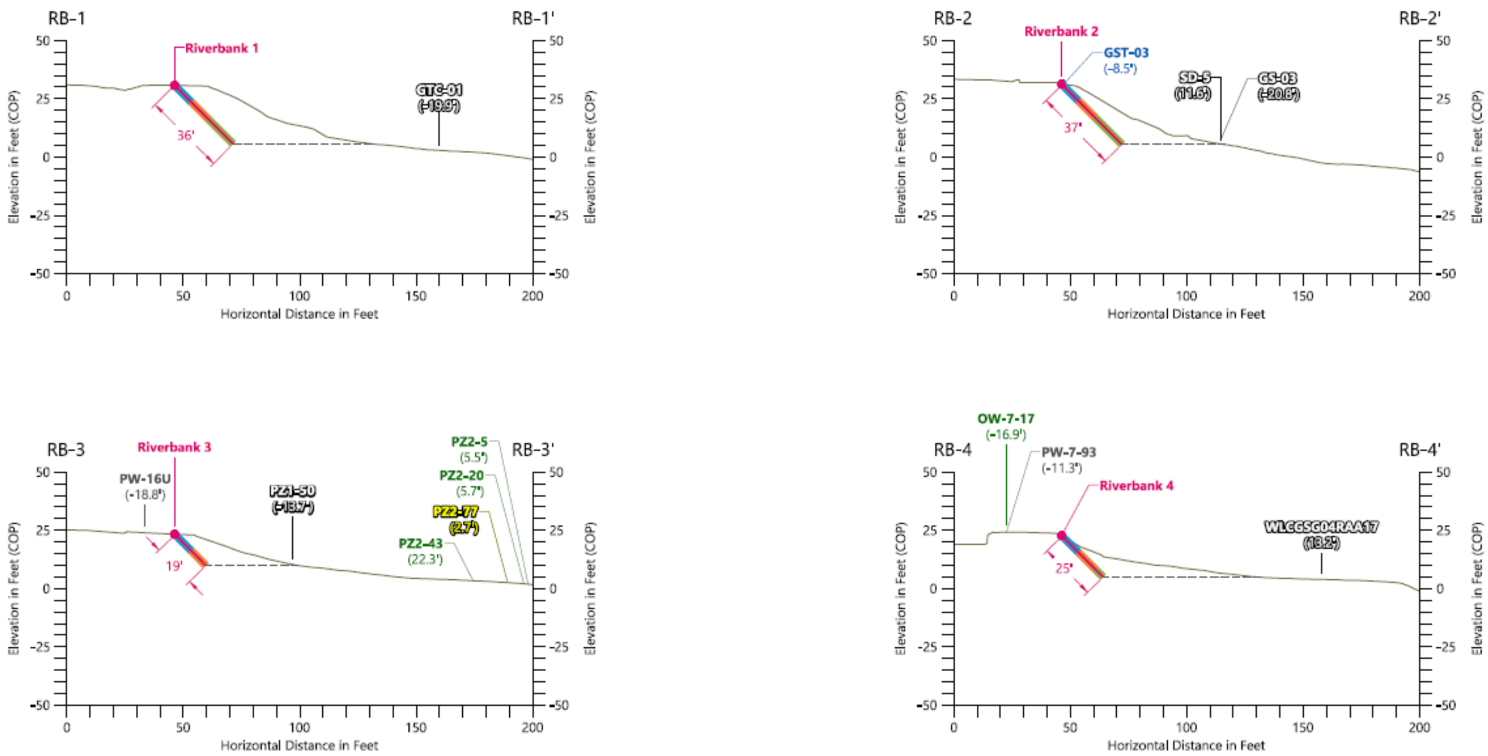
Subsurface Sediment: Riverbank Borings

- Objectives
  - Delineate vertical and lateral extent of PTW-NAPL
  - Support riverbank cap modeling demonstration
- Proposing eight angled borings along top of Gasco riverbank
  - Borings through the riverbank at Siltronic is infeasible
  - Bulk soil/sediment samples from 0 to 10 feet, 10 to 20 feet, and 20 feet to top of toe of riverbank core elevation
  - Analyze for ROD Table 17 analytes with groundwater CULs, ROD Table 17 analytes with river bank soil/sediment CULs, and ROD Table 21 RALs and PTW-highly toxic thresholds
  - Visual observations of PTW-NAPL per site-specific definition
  - Where present, located adjacent to upland areas containing DNAPL



Subsurface Sediment: Riverbank Boring Locations

Subsurface Sediment: Riverbank Boring Cross Sections



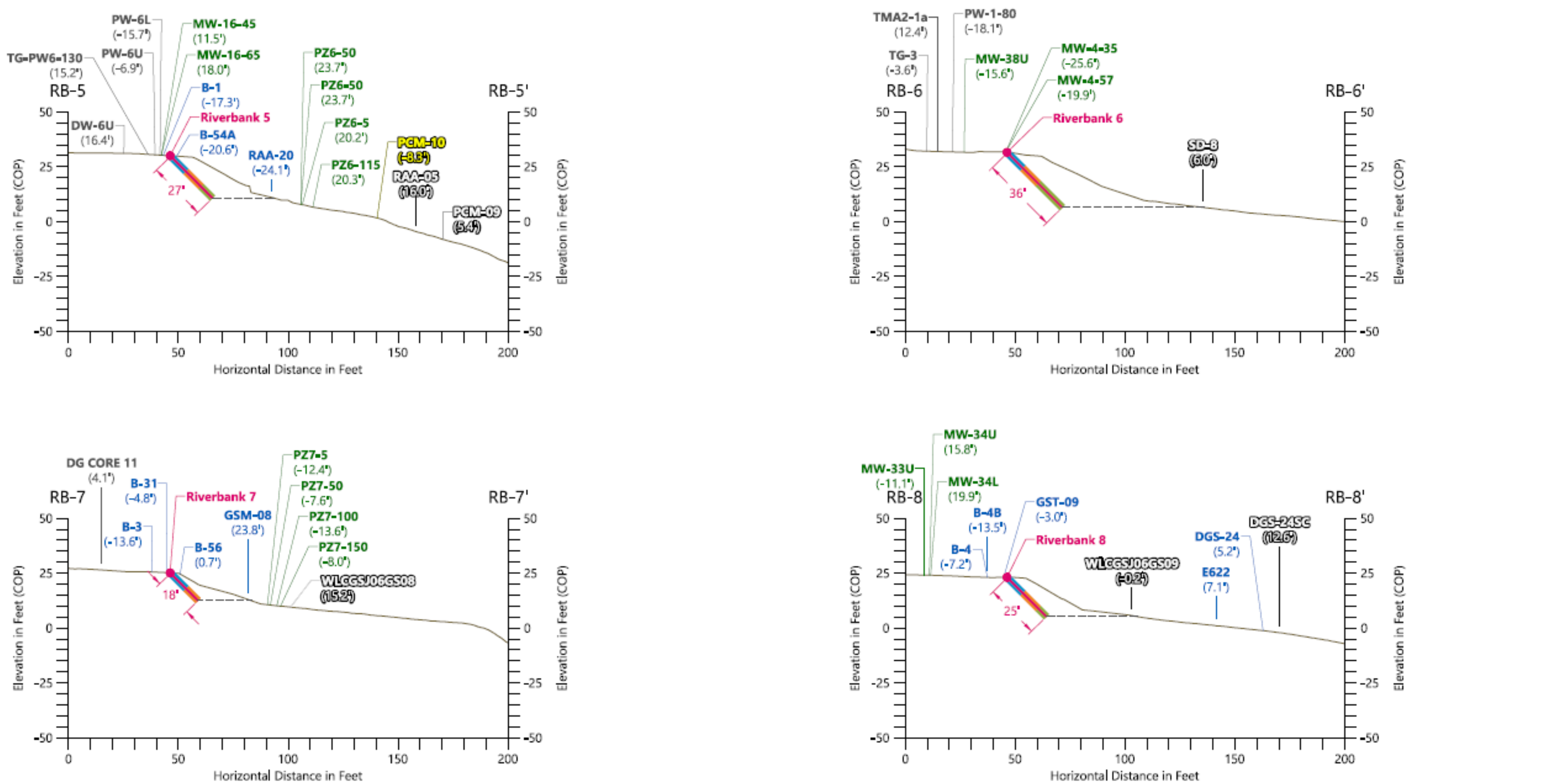
LEGEND:

- Proposed Riverbank Core
- XX Existing Sediment/Riverbank Sample Location
- XX Existing Groundwater Monitoring Sample Location
- XX Existing Upland Sample Location
- XX Existing Core with Previously Observed PTW-NAPL
- XX Existing Core without Previously Observed PTW-NAPL
- (X.X') Offset Distance in Feet
- 0'-10' Sample Interval
- 10'-20' Sample Interval
- 20'-Bottom of Core Sample Interval

0 50
Feet

HORIZONTAL DATUM: Oregon State Plane North, North American Datum of 1983 (NAD83/HARN 91), International Feet
VERTICAL DATUM: City of Portland (COP)
NOTE: Sampling will be performed at 0-3.5 feet, 3.5-12 feet, and 12 feet to remainder of length shown in each section above on a vertical basis. Actual sample lengths collected from each boring will be longer as a result of the boring being driven at an angle.

Subsurface Sediment: Riverbank Boring Cross Sections (cont.)



LEGEND:

- Proposed Riverbank Core
- XX Existing Sediment/Riverbank Sample Location
- XX Existing Groundwater Monitoring Sample Location
- XX Existing Upland Sample Location
- XX Existing Core with Previously Observed PTW-NAPL
- XX Existing Core without Previously Observed PTW-NAPL
- (X.X') Offset Distance in Feet
- 0'-10 Sample Interval
- 10'-20' Sample Interval
- 20'-Bottom of Core Sample Interval

0 50
Feet

HORIZONTAL DATUM: Oregon State Plane North, North American Datum of 1983 (NAD83/HARN 91), International Feet
VERTICAL DATUM: City of Portland (COP)
NOTE: Sampling will be performed at 0-3.5 feet, 3.5-12 feet, and 12 feet to remainder of length shown in each section above on a vertical basis. Actual sample lengths collected from each boring will be longer as a result of the boring being driven at an angle.

Dredge Material Handling, Transport, and Disposal Evaluation

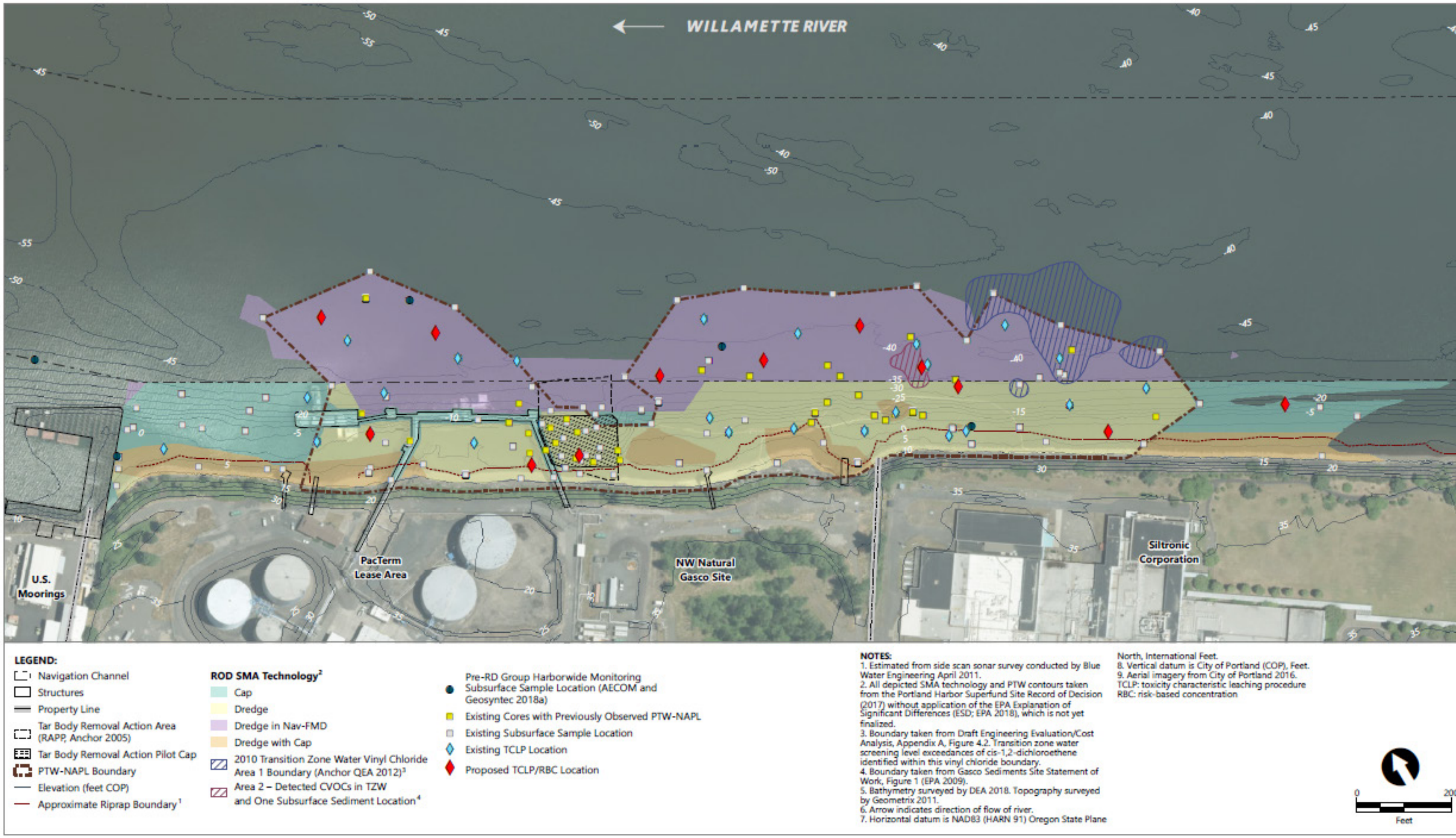
Subsurface Sediment: Waste Disposal Suitability Characterization

- Objective
  - Collect additional waste disposal suitability samples to characterize dredge material per density identified in the Gasco 2009 SOW (i.e., one sample per 10,000 cubic yards)
- Existing data density (23 locations) insufficient to characterize conservative dredge volume estimate
- Proposing collection of twelve cores throughout Project Area
- Bulk sediment samples will be composited from mudline to visually estimated DOC and analyzed for ignitability, corrosivity, potential F002 wastes (TCE; cis-DCE; trans-DCE; 1,1-DCE; and vinyl chloride), and COCs with TCLP criteria

Subsurface Sediment: Waste Disposal Suitability Characterization (cont.)

- TCLP elutriate analyzed for COCs with TCLP criteria (RCRA eight metals, VOCs, SVOCs, pesticides, and herbicides)
- Potential F002 wastes will be compared against occupational risk-based concentrations (DEQ 2018)
- The TCLP elutriate concentrations will be compared against the TCLP criteria defined in 40 CFR 261.24

Subsurface Sediment: Waste Characterization Proposed Sampling Locations



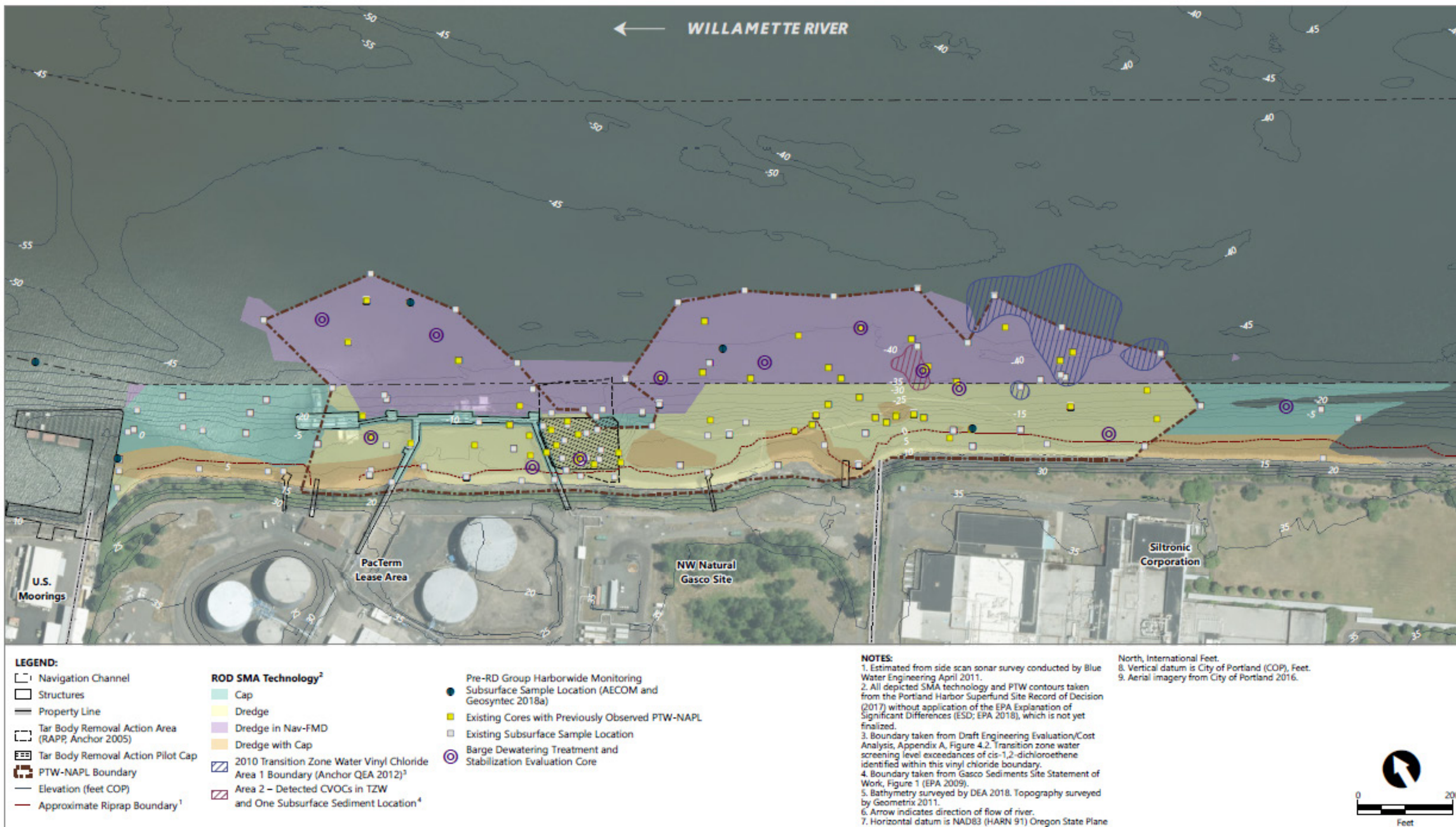
Subsurface Sediment: Barge Dewatering Treatment and Dredge Material Stabilization Evaluation

- Objectives
  - Estimate the quality of dredge material barge dewatering fluids to determine what type of treatment may be necessary prior to discharge back into the river in the work area
  - Estimate the type and amount of amendment that will be needed to make the sediment acceptable for transport and disposal at a landfill

Subsurface Sediment: Barge Dewatering Treatment and Dredge Material Stabilization Evaluation (cont.)

- Collect twelve 20-foot cores throughout the Project Area with range of chemical concentrations and presence/absence of PTW-NAPL
  - Full-depth bulk sediment samples will be composited from mudline to visually estimated DOC
  - River water in Project Area collected for use in the laboratory
    - Standard Elutriate Test samples will be analyzed for free cyanide, metals, PCBs, pesticides, PAHs, SVOCs, VOCs, pH, and TSS
    - Elutriate concentrations will be compared to freshwater acute water quality criteria (PAH ESBs, state, federal, ORNL)
  - Bench scale tests will be performed using a variety of amendment types and addition percentages to achieve transportation and disposal requirements

Subsurface Sediment: Barge Dewatering Treatment and Dredge Material Stabilization Evaluation Proposed Sampling Locations



Additional Analyses

Additional Analyses

- Although PAHs have the largest lateral and vertical extents of contamination exceeding the applicable RALs and PTW-highly toxic thresholds and therefore drive remedial design evaluations, EPA requested that a limited percentage (10%) of the data gaps sampling density also include characterization for non-PAH contaminants to document the unacceptable risks caused by these COCs
- As requested, NW Natural revised the sampling scope to include analyses of these non-PAH contaminants in more than 10% of the sample locations

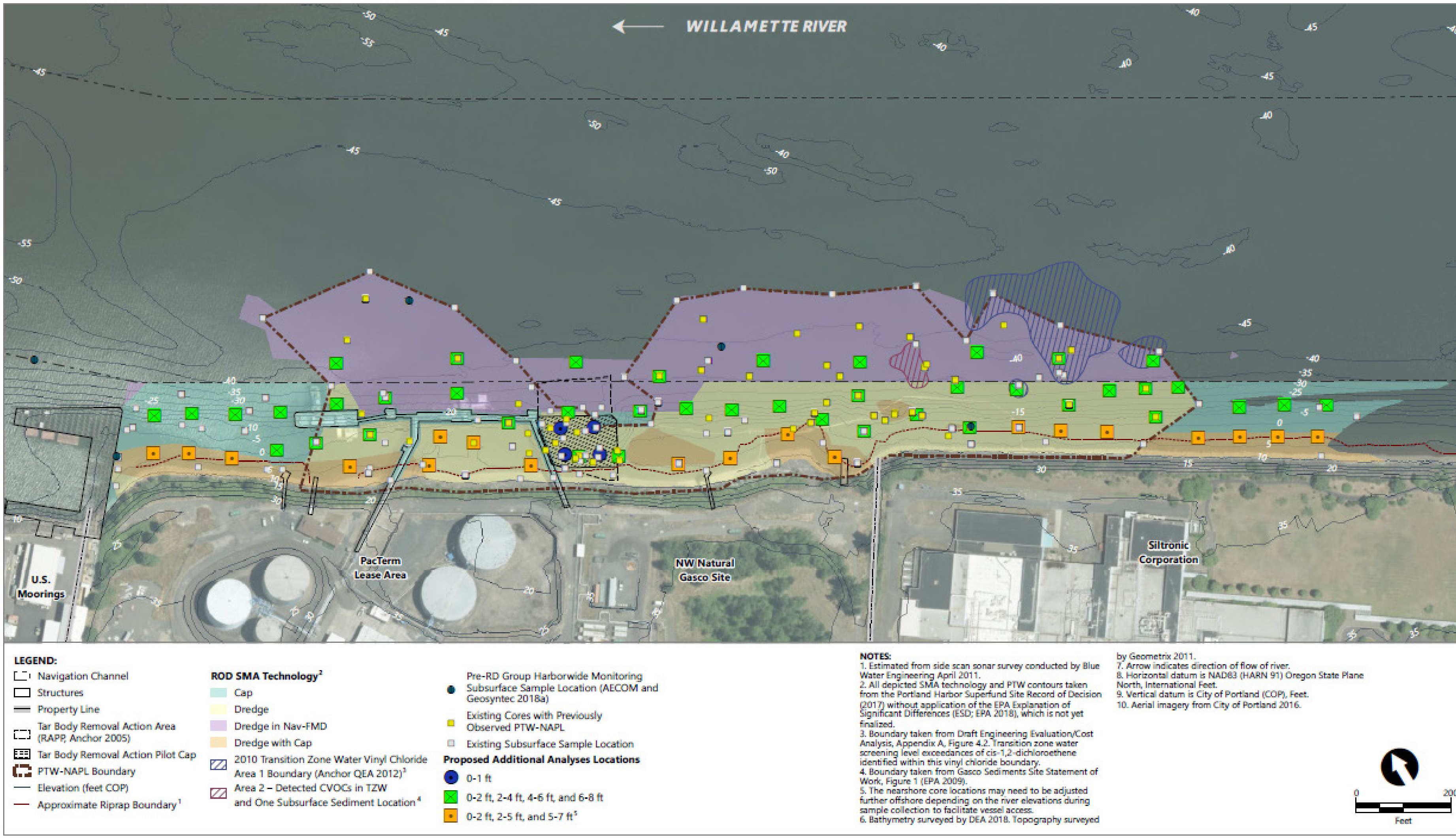
Additional Analyses: Surface Sediment Depositional Sediment Quality on 2005 Gasco Early Action Footprint

- Objective
  - Evaluate potential sediment recontamination from sediment deposition in the 2005 Gasco Early Action area
- Proposing four surface grabs (0 to 1 foot, if available)
  - Analyze for ROD Table 21 RALs and PTW-highly toxic thresholds
  - Analyze for ROD Table 17 river bank soil/sediment cleanup level analytes

Additional Analyses: Subsurface Sediment

- Analyze subsurface sediments for non-PAH ROD Table 21 RALs and PTW-highly toxic contaminants (i.e., PCBs, pesticides, and dioxins/furans) that are not proposed for remedial design data objectives
- Sediment cores will be subsampled in the upper four capping demonstration core intervals
  - 0 to 2 feet, 2 to 5 feet, 5 to 7 feet, and 7 to 10 feet in the shallow region
  - 0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet in the intermediate region

Additional Analysis Locations



Questions/Discussion

Appendix I
Memorandum Regarding “Addendum to the Pre-Remedial Design Data Gaps Work Plan – Gasco Sediments Site”

6720 SW Macadam Avenue, Suite 125
Portland, Oregon 97219
503.670.1108

ANCHOR QEA

Memorandum

July 3, 2019

To: Sean Sheldrake, U.S. Environmental Protection Agency

From: Ryan Barth, PE, Anchor QEA, LLC

cc: Karl Gustavson, U.S. Environmental Protection Agency
Bob Wyatt, NW Natural
Patty Dost, Pearl Legal Group
Lance Peterson, CDM Smith
Dana Bayuk, Oregon Department of Environmental Quality
Paul Schroeder, U.S. Army Corps of Engineers
Myron Burr, Siltronic Corporation
Michael Murray, Maul Foster & Alongi

Re: Addendum to the Pre-Remedial Design Data Gaps Work Plan – Gasco Sediments Site

NW Natural and Anchor QEA, LLC, provided the U.S. Environmental Protection Agency (EPA) and its partners a second technical briefing on June 21, 2019, to describe revisions incorporated in response to EPA comments on the initial briefing provided on November 27, 2018, and to summarize and answer any initial questions on the scope of work described in the *Pre-Remedial Design Data Gaps Work Plan* (DGWP; Anchor QEA 2019a) submitted to EPA on June 10, 2019. Following the meeting, CDM Smith discussed with Anchor QEA some samples in the initial presentation that were removed from the upriver edge of the Project Area in the second presentation. Those samples were not included in the second briefing or in the DGWP because they are located in a different "B" area designation on EPA's Plan B map (Figure 2 in the DGWP). CDM Smith clarified that was a misunderstanding, and that those samples should be retained. As soon as this misunderstanding became clear, NW Natural agreed to return those samples to the DGWP.

CDM Smith also discussed with Anchor QEA EPA's request for NW Natural to evaluate whether there are any areas surrounding the perimeter of the Gasco Sediments Site Project Area that do not contain surface sediment *Record of Decision – Portland Harbor Superfund Site, Portland, Oregon* (ROD; EPA 2017) Table 21 remedial action level [RAL] and principal threat waste [PTW]-highly toxic threshold exceedances but do contain exceedances in deeper subsurface sediments (i.e., buried contamination). NW Natural also agreed to perform this evaluation.

The remainder of this memorandum describes NW Natural's additional proposed sampling activities based on these discussions and agreements with EPA and serves as an addendum to the DGWP. Attachment A provides updated figures for the DGWP, Attachment B provides updated tables for Appendix A of the DGWP, and Attachment C provides updated figures for Appendix A of the DGWP.

Samples Returned to the DGWP to Resolve the Misunderstanding

The samples discussed in the following subsections were included in NW Natural and Anchor QEA's initial November 27, 2018 technical briefing presentation; however, due to the misunderstanding described in the introductory paragraph of this memorandum, the samples were removed from the second briefing and were not included in the June 10, 2019 submittal of the DGWP. The following subsections describe the surface grab sample and subsurface sediment cores and borings that have been reinserted into the DGWP to resolve the misunderstanding.

Surface Grab Sample

NW Natural reinserted the collection of a three-point composite surface grab at location DGS-34 to determine the current contaminant concentrations at that location. As described in Appendix A of the *Draft Engineering Evaluation/Cost Analysis* (Anchor QEA 2012), NW Natural collected two approximately co-located surface sediment grabs at location DGS-34 (Figure 3 in Attachment A) in October 2010 and April 2011 during the performance of site-specific benthic toxicity testing to support the refinement of the Project Area. The October 2010 total polycyclic aromatic hydrocarbon (TPAH) concentration of 4,800 parts per billion (ppb) is significantly less than the April 2011 data (190,000 ppb) and ROD-identified TPAH RAL (170,000 ppb). Due to the slight April 2011 TPAH RAL exceedance, the ROD identified a very small sediment management area (SMA) directly surrounding the DGS-34 sampling location (Figure 3 in Attachment A). The grab sample will be analyzed for the chemicals containing ROD Table 21 RALs and PTW-highly toxic thresholds[1], and the measured concentrations will be compared against the RALs and PTW-highly toxic thresholds to determine if this area should be within the Project Area. The sample will also be visually assessed for the presence of PTW-nonaqueous phase liquid (NAPL) identified in the ROD and detailed in the DGWP (Anchor QEA 2019a).

Subsurface Sediment Cores and Borings

NW Natural reinserted the collection of a total of seven 20-foot vibracores and three variable-depth geotechnical borings in the intermediate and shallow regions on the upriver edge of the Project Area identified as capping in the ROD. These cores and borings will collect data necessary to complete the Gasco Sediments Site remedial design technical evaluations described in the *Final Revised Pre-Remedial Basis of Design Technical Evaluations Work Plan* (Anchor QEA 2019b) submitted to EPA on June 10, 2019. A summary of the proposed subsurface data collection activities is provided in the following subsections.

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[1] As detailed in the DGWP, NW Natural will not apply the PTW-not reliably contained (NRC) threshold presented in ROD Tables 7 and 21 because the PTW-NRC thresholds for these chemicals are based on harborwide capping assumptions that do not apply at the Gasco Sediments Site. As described in Section 3.1.1 of the DGWP, NW Natural will develop site-specific PTW-NRC thresholds, if any, in the *Pre-Remedial Design Basis of Design Report* via the capping demonstration evaluation.

Sediment Cores – Cap Chemical Isolation Modeling Evaluations

NW Natural reinserted three cores in the intermediate region and four cores in the shallow region, as shown in Figure 6 of Attachment A. Consistent with Section 3.2.1.1.1 of the DGWP, these cores will be used to perform bulk subsurface sediment chemical analyses and subsequent calculation of porewater concentrations using empirically derived and site-specific or literature-derived equilibrium partitioning coefficients. The resulting site-specific porewater concentrations will be used as input parameters for the cap design model. Each core will be sampled consistently with the sampling design and methods identified in Sections 3.2.1.1.1 and 3.2.1.2.1 in the DGWP, respectively, and spaced approximately every 150 feet to provide representative horizontal spatial coverage. In summary, each core in the intermediate region will be sampled in successive 2-foot composite sediment intervals from the existing mudline to the bottom recovered depth of the core. Each composite sediment interval will be analyzed for polycyclic aromatic hydrocarbons (PAHs), volatile organic compounds (VOCs with ROD Table 17 groundwater cleanup levels), and arsenic. The entire length of core will also be visually assessed for the presence of PTW-NAPL using the site-specific definition detailed in the DGWP. Alternatively, in the shallow region, each core will be sampled in the following successive, composite intervals: 0 to 2 feet, 2 to 5 feet, 5 to 7 feet, 7 to 10 feet, and 10 to 13 feet. While logging a core, if PTW-NAPL is identified below 13 feet, sampling will continue in consecutive 2-foot composite sediment intervals to the bottom penetration depth of the core. Consistent with the intermediate region cores, each composite depth interval will be analyzed for PAHs, VOCs, and arsenic. Physical analyses for all intermediate and shallow region cores will include total organic carbon, total solids, moisture content, specific gravity, grain size, and Atterberg limits.

Sediment Cores – Dredge Material Handling, Transport, and Disposal Evaluation

NW Natural reinserted the collection of a single 20-foot vibracore in the intermediate region to provide data for the evaluation of dredge material handling, transport, and disposal, as detailed in Section 3.5 of the DGWP. The core will be collected and sampled consistently with the design and methods identified in Sections 3.5.1 and 3.5.2 in the DGWP, respectively. In summary, the following testing will be performed:

- **Dredge Material Haul Barge Dewatering:** This will be performed via the collection of river water and bulk sediment representative of potential dredge materials. The bulk sediment will consist of one vertically composited sample interval from the existing surface to the depth of contamination (DOC; or bottom of the core if DOC is unbounded), which will be estimated in the field based on visual and olfactory indications of contamination. This testing will include mixing the sediment and water in a specified ratio, followed by agitation of the slurry mixture for a specified period, settling or filtration of solids, and analysis of the resulting water column. Standard elutriate tests will be conducted in accordance with national dredged material disposal guidelines (EPA and USACE 1991). The elutriate sample will be analyzed for the ROD Table 17 chemicals with groundwater cleanup levels. These chemicals include free cyanide, metals, PCBs, pesticides, PAHs, semivolatile organic compounds (SVOCs), VOCs, pH, and total suspended solids. The elutriate concentrations will be compared against the water quality standards identified in Section 3.5.1.1 of the DGWP.

- **Dredge Material Stabilization Testing:** This will be performed using the vertically composited bulk sediment sample volume collected for the dredge material haul barge dewatering testing. Dredge material stabilization tests will be performed using various pozzolanic materials (e.g., Portland cement, calciment, lime kiln dust) and material dosages to determine the appropriate amendment to cost-effectively stabilize dredge material so it meets the applicable transport and disposal facility material strength requirements. Stabilization will be performed using a variety of amendment types and dosages described in Appendix A of the DGWP. Optimum dosage ratios will be evaluated through paint filter testing, percent solids analysis, and visual observations of physical characteristics at specified cure periods (e.g., 24 hours, 48 hours, and 72 hours). The goal is to determine the most optimum combination of amendment, dosage ratio, and cure time to allow the stabilized end product to pass the paint filter test and meet the minimum structural strength required by the disposal facility.
- **Dredge Material Disposal Suitability Testing:** This will be performed using the vertically composited bulk sediment sample volume collected for the dredge material haul barge dewatering testing. The composite sample will be analyzed for the following:
  - Resource Conservation and Recovery Act (RCRA) waste characteristics (ignitability and corrosivity)
  - F002 wastes (TCE; cis-DCE; trans-DCE; 1,1-DCE; and vinyl chloride)
  - Toxicity characteristic leaching procedure (TCLP) analytes (RCRA eight metals, VOCs, SVOCs, pesticides, and herbicides)

  Initially, each composite sample will be analyzed for the above parameters without any dewatering amendment. If no RCRA waste characteristics are identified and there are no exceedances of the TCLP- or F002-related occupational risk-based concentrations (RBCs), no additional testing will be performed. Alternatively, for any unamended samples that contain RCRA waste characteristics or exceedances of the TCLP- or F002-related occupational RBCs, the samples will be stabilized with dewatering amendments and retested (only for the applicable tests driving the amendment addition).

Sediment Borings – Geotechnical Evaluations

NW Natural reinserted the collection of three geotechnical borings to provide data for the evaluation of slope stability and bearing capacity, settlement, and seismically induced settlement, as detailed in Section 3.2.3 of the DGWP. Each core will be collected and sampled consistently with the sampling design and methods identified in Sections 3.2.3.1 and 3.2.3.2 in the DGWP, respectively. In summary, the borings will be collected using a barge-mounted sonic drill rig and drill methods in general accordance with ASTM D6914. The borings will be spaced between 100 to 200 feet apart to provide representative horizontal spatial coverage. Two ex situ sonic core locations will be performed for standard penetration tests (SPTs) and one location for in situ penetration tests (full-flow penetration [FFP] and cone penetration tests with pore pressure measurement [CPTu]), as shown in Figure 8 of Attachment A. For the SPT borings, one to five samples will be collected per core for geotechnical laboratory analysis depending on sediment thickness and lithology. Each of the samples will be analyzed for moisture content, Atterberg limits, grain size, specific gravity, dry bulk density, one-dimensional consolidation, direct shear strength, and triaxial shear strength. In addition, SPT blow counts will be recorded on field forms for every 5 feet of boring advancement. For the FFP and CPTu borings, data will be continuously collected during testing as the probe is pushed into sediment, and no physical samples will be collected. The termination depth for the geotechnical tests at each proposed location will be determined by the conditions described in Section 3.2.3.2 of the DGWP.

Subsurface Sediment Data Collection Outside the Project Area

NW Natural proposes the collection of a single additional 20-foot vibracore outboard of the PTW-NAPL boundary, as shown in Figure 13 of Attachment A, to better understand the vertical chemical concentration profile at this location outside the Project Area. This core will be sampled in successive 1-foot depth intervals throughout the full penetration depth. Chemical analyses will initially be performed on the 0- to 1-foot, 1- to 2-foot, 2- to 3-foot, and 3- to 4-foot depth intervals for chemicals containing ROD Table 21 RALs and PTW-highly toxic thresholds. The remainder of the underlying depth intervals will be archived pending evaluation of the overlying chemical concentrations. This is the only area identified where subsurface impacts need to be refined proximate to the ROD-identified SMA boundary.

References

Anchor QEA (Anchor QEA, LLC), 2012. *Draft Engineering Evaluation/Cost Analysis*. Gasco Sediments Cleanup Site. Prepared for the U.S. Environmental Protection Agency, Region 10. Prepared on behalf of NW Natural. May 2012.

Anchor QEA, 2019a. *Pre-Remedial Design Data Gaps Work Plan*. Prepared for the U.S. Environmental Protection Agency. Prepared on behalf of NW Natural. June 10. 2019.

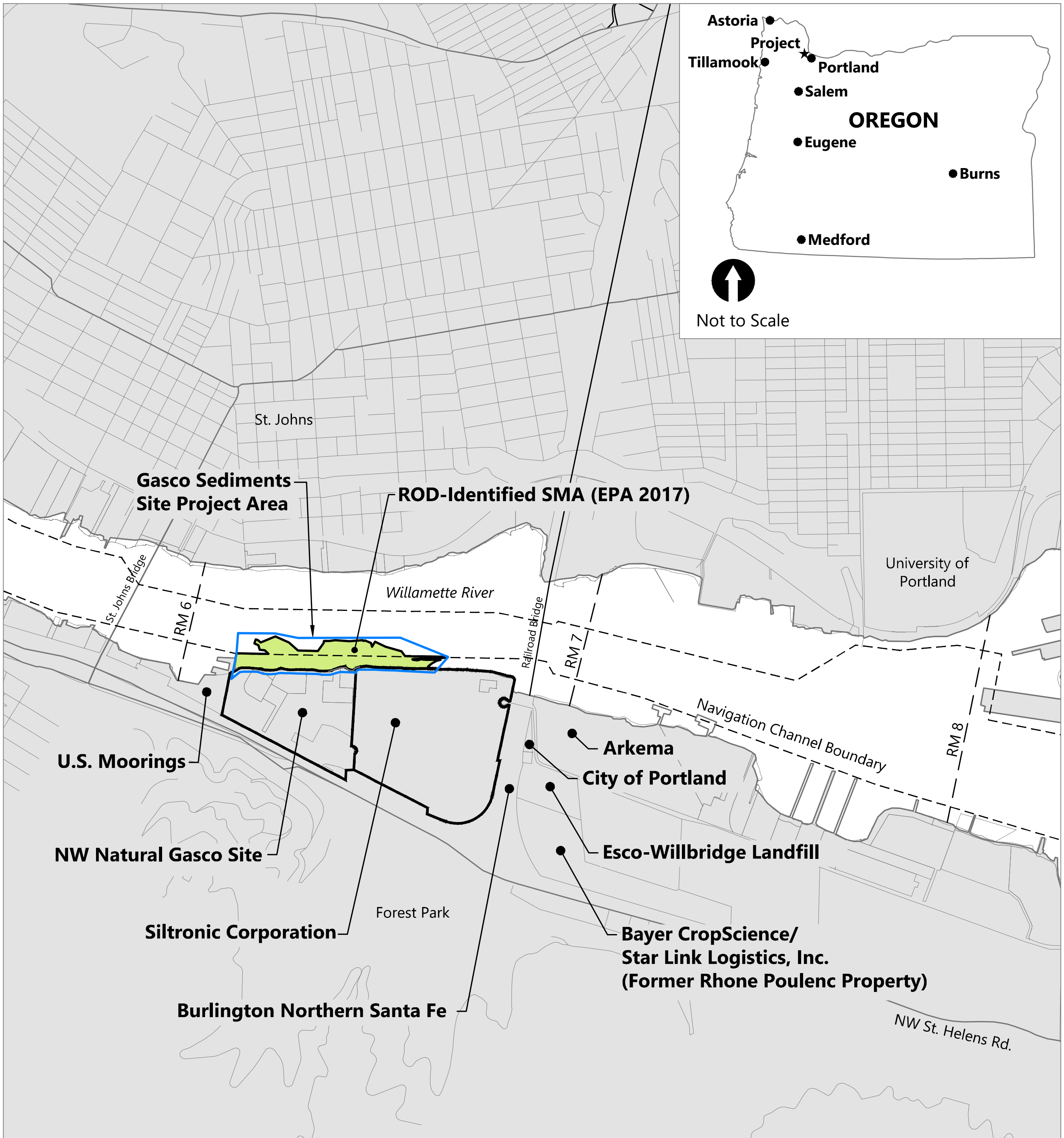
Anchor QEA, 2019b. *Final Revised Pre-Remedial Basis of Design Technical Evaluations Work Plan*. Prepared for the U.S. Environmental Protection Agency. Prepared on behalf of NW Natural. June 10. 2019.

EPA (U.S. Environmental Protection Agency), 2017. *Record of Decision, Portland Harbor Superfund Site, Portland, Oregon*. U.S. Environmental Protection Agency Region 10. January 2017.

EPA and USACE (U.S. Army Corps of Engineers), 1991. *Evaluation of Dredged Material Proposed for Ocean Disposal: Testing Manual*. Office of Water. EPA 503/8-91/001. February 1991.

Attachment A

DGWP Updated Figures



HORIZONTAL DATUM: Oregon State Plane North, North American Datum (NAD83/HARN 91), International Feet.

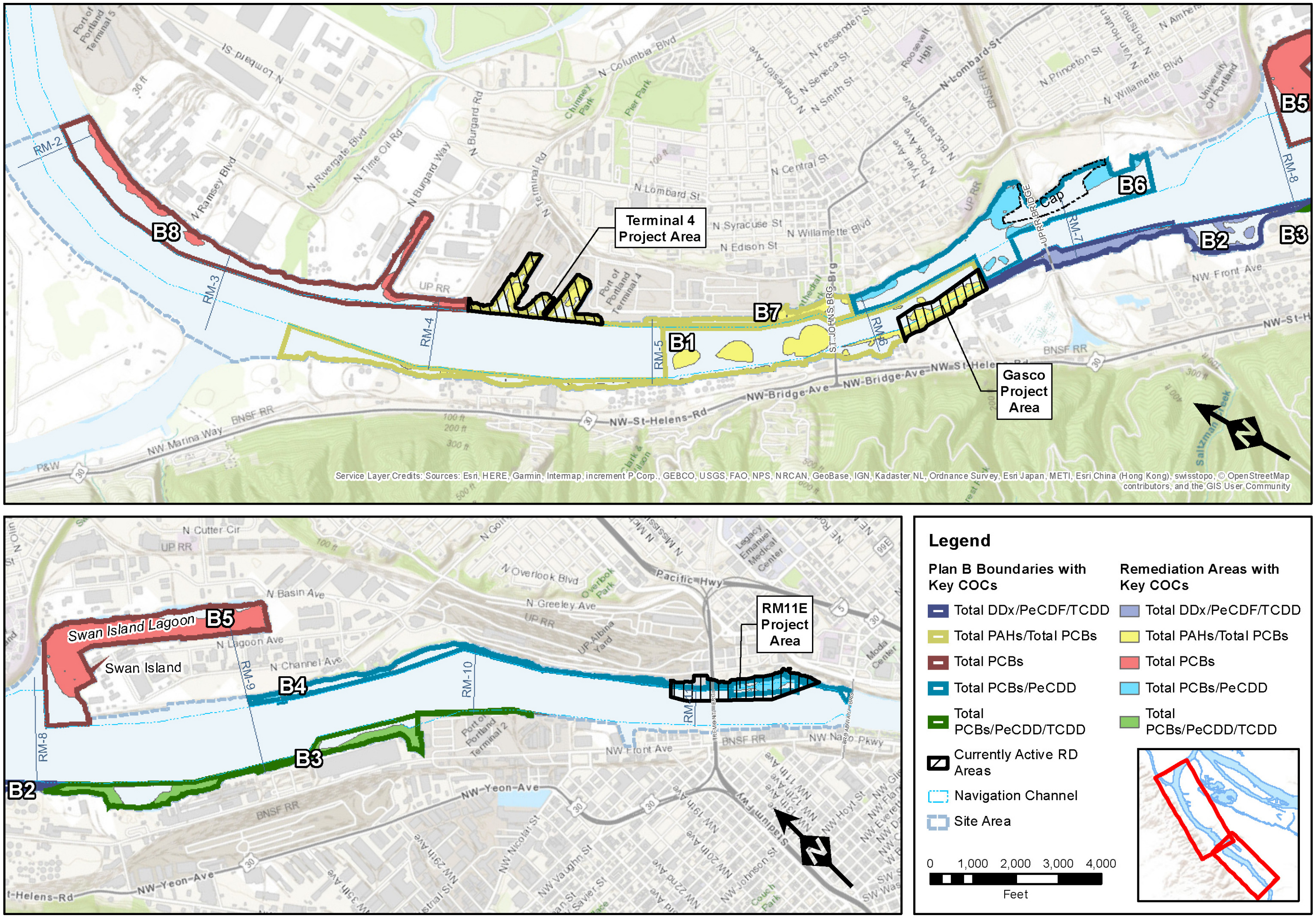
NOTE: All locations are approximate.

Publish Date: 2019/07/01 10:00 AM | User: hmerrick
Filepath: K:\Projects\0029-NW Natural Gas Co\Gasco Sediments_Pre-Remedial Design\Pre_RD Data Gaps SAP\0029-RP-002 (Vicinity Map).dwg Figure 1 WP

ANCHOR QEA

Figure 1
Vicinity Map

Pre-Remedial Design Data Gaps Work Plan
Gasco Sediments Cleanup Action



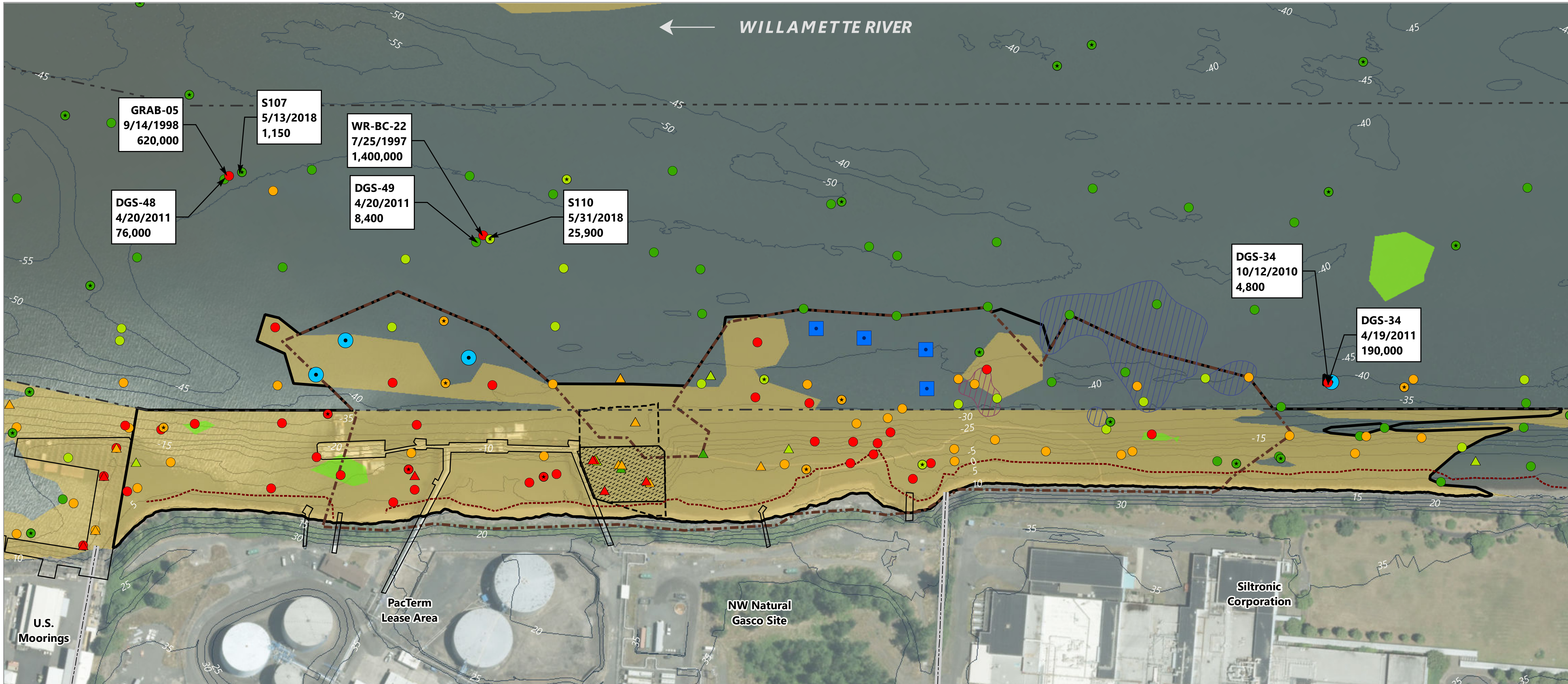
Project Areas
Portland Harbor Superfund Site

EPA document dated March 7, 2019

Filepath: \\orcas\GIS\Jobs\NW_Natural_Gas_0029\Gasco_Sediments\Maps\Reports\DataGapsWorkPlan2018\AQ_DGWP_Fig02_EPAProjectAreas.docx

ANCHOR QEA

Figure 2
EPA-Identified Gasco Project Area
Pre-Remedial Design Data Gaps Work Plan
Gasco Sediments Cleanup Action



LEGEND:

- Navigation Channel
- Structures
- Property Line
- Tar Body Removal Action Area (RAPP, Anchor 2005)
- Tar Body Removal Action Pilot Cap
- PTW-NAPL Boundary
- Elevation (feet COP)
- Approximate Riprap Boundary[1]
- ROD-Identified SMAs (EPA 2017) Included in the Ga sco Sedim ent Site Interim Project Area[2]
- Total Area Exceeding ROD Table 21 Focused COC RALs and PTW-Highly Toxic Additional Contaminant Thresholds[4]
- Total PCB PTW-Highly Toxic Additional Contaminant Threshold Exceedance
- 2010 Transition Zone Water Vinyl Chloride Area 1 Boundary (Anchor QEA 2012)[5]
- Area 2 – Detected CVOCs in TZW and One Subsurface Sediment Location[6]

Total PAH (µg/kg)

- ≤ ROD RAL (13,000)
- > ROD RAL (13,000) and ≤ ROD RAL ESD (30,000)
- > ROD RAL ESD (30,000) and ≤ Nav ROD RAL (170,000)
- > Nav ROD RAL (170,000)

- Pre-RD Group Harborwide Monitoring Surface Sample Location (AECOM and Geosyntec 2018a)
- Surface Sample Locations Not Included in the ROD
- Surface Sample Location Included in the ROD
- Proposed Interim Project Area Verification Surface Sediment Grab
- Proposed 0- to 1-Foot Interval For Additional Surface Sediment Concentration Data Density

NOTES:

1. Estimated from side scan sonar survey conducted by Blue Water Engineering April 2011.
2. All depicted SMA technology and PTW contours taken from the Portland Harbor Superfund Site Record of Decision (2017) without application of the EPA Explanation of Significant Differences (ESD; EPA 2018), which is not yet finalized.
3. Total area determined based on exceedances of ROD Table 21 focused COC RALs and PTW-highly toxic additional contaminant thresholds. Does not account for ESD, which is still undergoing public review and comment.
4. Boundary taken from Draft Engineering Evaluation/Cost Analysis, Appendix A, Figure 4.2. Transition zone water screening level exceedances of cis-1,2-dichloroethene identified within this vinyl chloride boundary.
5. Boundary taken from Gasco Sediments Site Statement of Work, Figure 1 (EPA 2009).
6. Bathymetry surveyed by DEA 2018. Topography surveyed by Geometrix 2011.
7. Arrow indicates direction of flow of river.
8. Horizontal datum is NAD83 (HARN 91) Oregon State Plane North, International Feet.
9. Vertical datum is City of Portland (COP), Feet.
10. Aerial imagery from City of Portland 2016.

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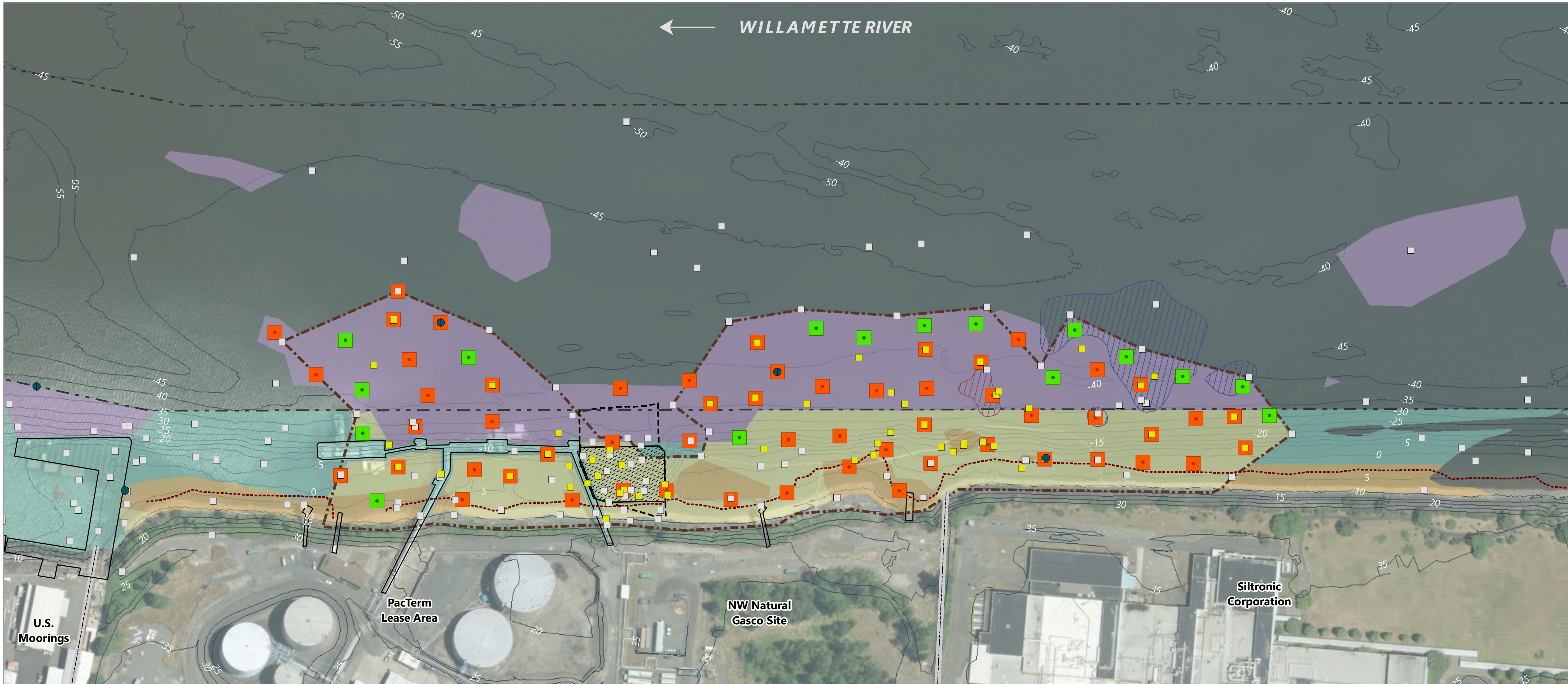
ANCHOR QEA

Figure 3
Proposed Interim Project Area Surface Sediment Grabs
Pre-Remedial Design Data Gaps Work Plan
Gasco Sediments Cleanup Action



LEGEND:

- Navigation Channel
- Structures
- Property Line
- Tar Body Removal Action Area (RAPP, Anchor 2005)
- Tar Body Removal Action Pilot Cap
- PTW-NAPL Boundary
- Elevation (feet COP)
- Approximate Riprap Boundary[1]

ROD SMA Technology[2]

- Cap
- Dredge
- Dredge in Nav-FMD
- Dredge with Cap
- 2010 Transition Zone Water Vinyl Chloride Area 1 Boundary (Anchor QEA 2012)[3]
- Area 2 – Detected CVOCs in TZW and One Subsurface Sediment Location[4]

- Pre-RD Group Harborwide Monitoring Subsurface Sample Location (AECOM and Geosyntec 2018a)
- Existing Cores with Previously Observed PTW-NAPL
- Existing Subsurface Sample Location
- Proposed DOC Core[5]
- Proposed DOC and PTW-NAPL Refinement Core

NOTES:

1. Estimated from side scan sonar survey conducted by Blue Water Engineering April 2011.
2. All depicted SMA technology and PTW contours taken from the Portland Harbor Superfund Site Record of Decision (2017) without application of the EPA Explanation of Significant Differences (ESD; EPA 2018), which is not yet finalized.
3. Boundary taken from Draft Engineering Evaluation/Cost Analysis, Appendix A, Figure 4.2. Transition zone water screening level exceedances of cis-1,2-dichloroethene identified within this vinyl chloride boundary.
4. Boundary taken from Gasco Sediments Site Statement of Work, Figure 1 (EPA 2009).
5. The nearshore core locations may need to be adjusted further offshore depending on the river elevations during sample collection to facilitate vessel access.
6. Bathymetry surveyed by DEA 2018. Topography surveyed by Geometrix 2011.
7. Arrow indicates direction of flow of river.
8. Horizontal datum is NAD83 (HARN 91) Oregon State Plane North, International Feet.
9. Vertical datum is City of Portland (COP), Feet.
10. Aerial imagery from City of Portland 2016.

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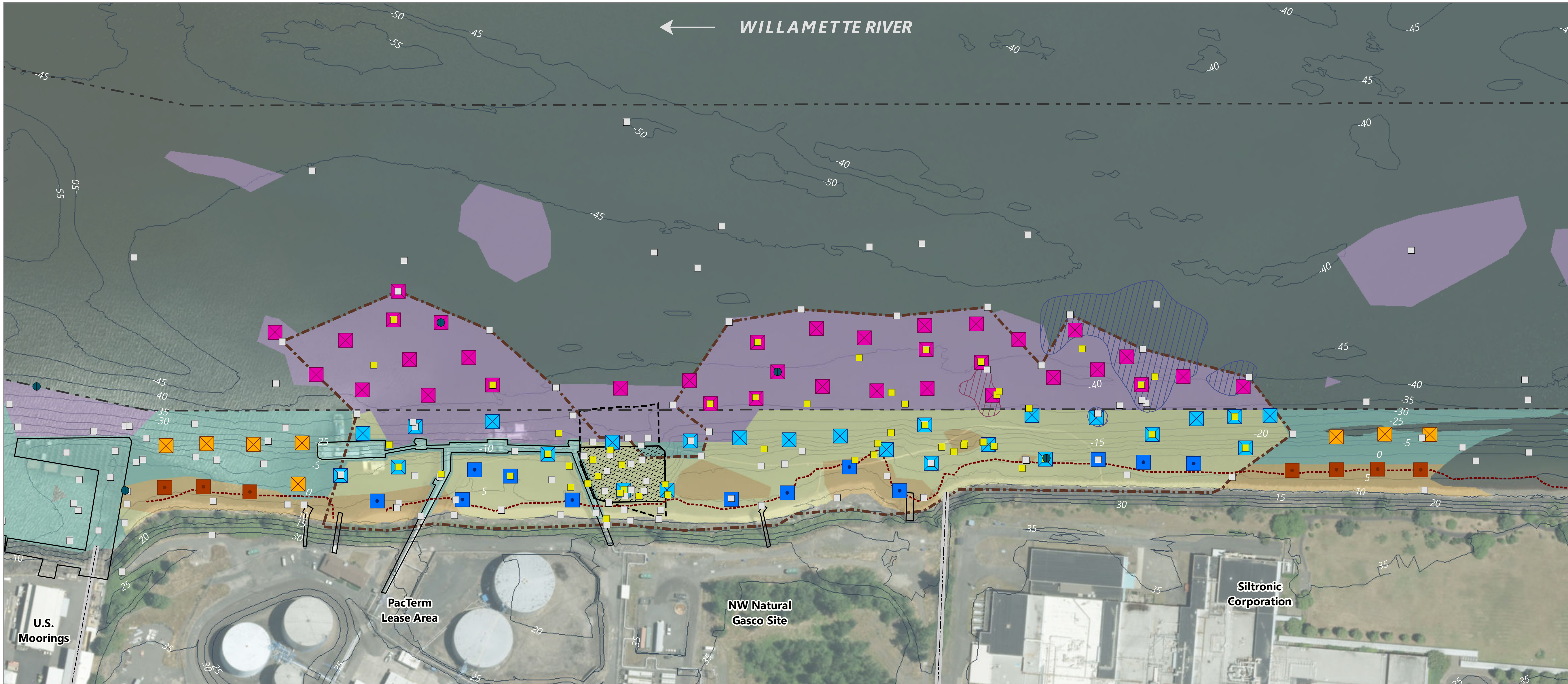
Figure 4
Proposed Subsurface Depth of Contamination and PTW-NAPL Boundary Refinement Cores
Pre-Remedial Design Data Gaps Work Plan
Gasco Sediments Cleanup Action

Habitat Layer	Material type and thickness to be determined during remedial design in coordination with EPA and resource agency. No data gaps identified.
Erosion Resistance Layer	The need for an erosion resistance layer and design, if necessary, will be evaluated during a desktop review of data sources described in Section 2.1.2 of the Pre-Remedial Design Data Gaps Work Plan. No data gaps identified.
Geotechnical Filter Layer	If a filter layer is necessary to prevent fine-grained chemical isolation layer materials from migrating upward through pore spaces in the coarse-grained erosion resistance layer, the gradation of the chemical isolation materials and erosion resistance layer materials will be used to design the filter layer. No data gaps identified.
Chemical Isolation Layer	Material type and thickness to be determined based on measured groundwater flows and porewater chemical concentrations converted from bulk sediment chemical concentrations using site-specific and literature equilibrium partitioning coefficients. Data gaps are identified in Section 3.2.1 of the Pre-Remedial Design Data Gaps Work Plan.
PTW Reactive Layer	Material type and thickness will be determined based on calculated PTW-NAPL mass loading by advection, ebullition-facilitation PTW-NAPL transport, and PTW-NAPL transport from sediment consolidation following cap placement. Data gaps are identified in Section 3.2.2 of the Pre-Remedial Design Data Gaps Work Plan.
Underlying Sediment	Sediment geotechnical parameters will be used to design caps and inform cap placement requirements to account for slope stability and bearing capacity concerns and post-placement consolidation. Data gaps are identified in Section 3.2.3 of the Pre-Remedial Design Data Gaps Work Plan.

NOTE

1. Layers of this conceptual cap cross section are not drawn to scale and will be determined during technical evaluations and remedial design.

Figure 5
Capping Demonstration – Conceptual Isolation Cap Cross Section with Design Evaluation Data Uses



LEGEND:

- Navigation Channel
- Structures
- Property Line
- Tar Body Removal Action Area (RAPP, Anchor 2005)
- Tar Body Removal Action Pilot Cap
- PTW-NAPL Boundary
- Elevation (feet COP)
- Approximate Riprap Boundary[1]

ROD SMA Technology[2]

- Cap
- Dredge
- Dredge in Nav-FMD
- Dredge with Cap
- 2010 Transition Zone Water Vinyl Chloride Area 1 Boundary (Anchor QEA 2012)[3]
- Area 2 – Detected CVOCs in TZW and One Subsurface Sediment Location[4]

- Pre-RD Group Harborwide Monitoring Subsurface Sample Location (AECOM and Geosyntec 2018a)
- Existing Cores with Previously Observed PTW-NAPL
- Existing Subsurface Sample Location

Proposed Capping Only Cores

- Consecutive 2-ft Intervals Throughout Core Penetration Depth
- 0-2 ft, 2-5 ft, 5-7 ft, 7-10 ft, and 10-13 ft Intervals[5,6]

Proposed Dredge and Cap Cores[7]

- Consecutive 2-ft Intervals Throughout Core Penetration Depth
- 0-2 ft, 2-5 ft, 5-7 ft, 7-10 ft, and 10-13 ft Intervals[5,6]
- Consecutive 2-ft Intervals Throughout Core Penetration Depth Initiating at -47 Feet COP Elevation[8]

NOTES:

1. Estimated from side scan sonar survey conducted by Blue Water Engineering April 2011.
2. All depicted SMA technology and PTW contours taken from the Portland Harbor Superfund Site Record of Decision (2017) without application of the EPA Explanation of Significant Differences (ESD; EPA 2018), which is not yet finalized.
3. Boundary taken from Draft Engineering Evaluation/Cost Analysis, Appendix A, Figure 4.2. Transition zone water screening level exceedances of cis-1,2-dichloroethene identified within this vinyl chloride boundary.
4. Boundary taken from Gasco Sediments Site Statement of Work, Figure 1 (EPA 2009).
5. Potentially deeper samples will be collected if PTW-NAPL is identified. NAPL mobility testing may be conducted based on PTW-NAPL observations in deeper intervals.
6. The nearshore core locations may need to be adjusted further offshore depending on the river elevations during sample collection to facilitate vessel access.
7. All dredge and cap core locations are identical to DOC locations shown in Figure 5.
8. Capping in the channel becomes feasible in the navigation channel below -47 feet COP, based on ROD-identified -43 feet Columbia River Datum (CRD) authorized federal maintenance dredging elevation plus 3 feet overdredge plus 4- to 5-foot underlying cap thickness plus conversion from CRD to COP datum.
9. Bathymetry surveyed by DEA 2018. Topography surveyed by Geometrix 2011.
10. Arrow indicates direction of flow of river.
11. Horizontal datum is NAD83 (HARN 91) Oregon State Plane North, International Feet.
12. Vertical datum is City of Portland (COP), Feet.
13. Aerial imagery from City of Portland 2016.

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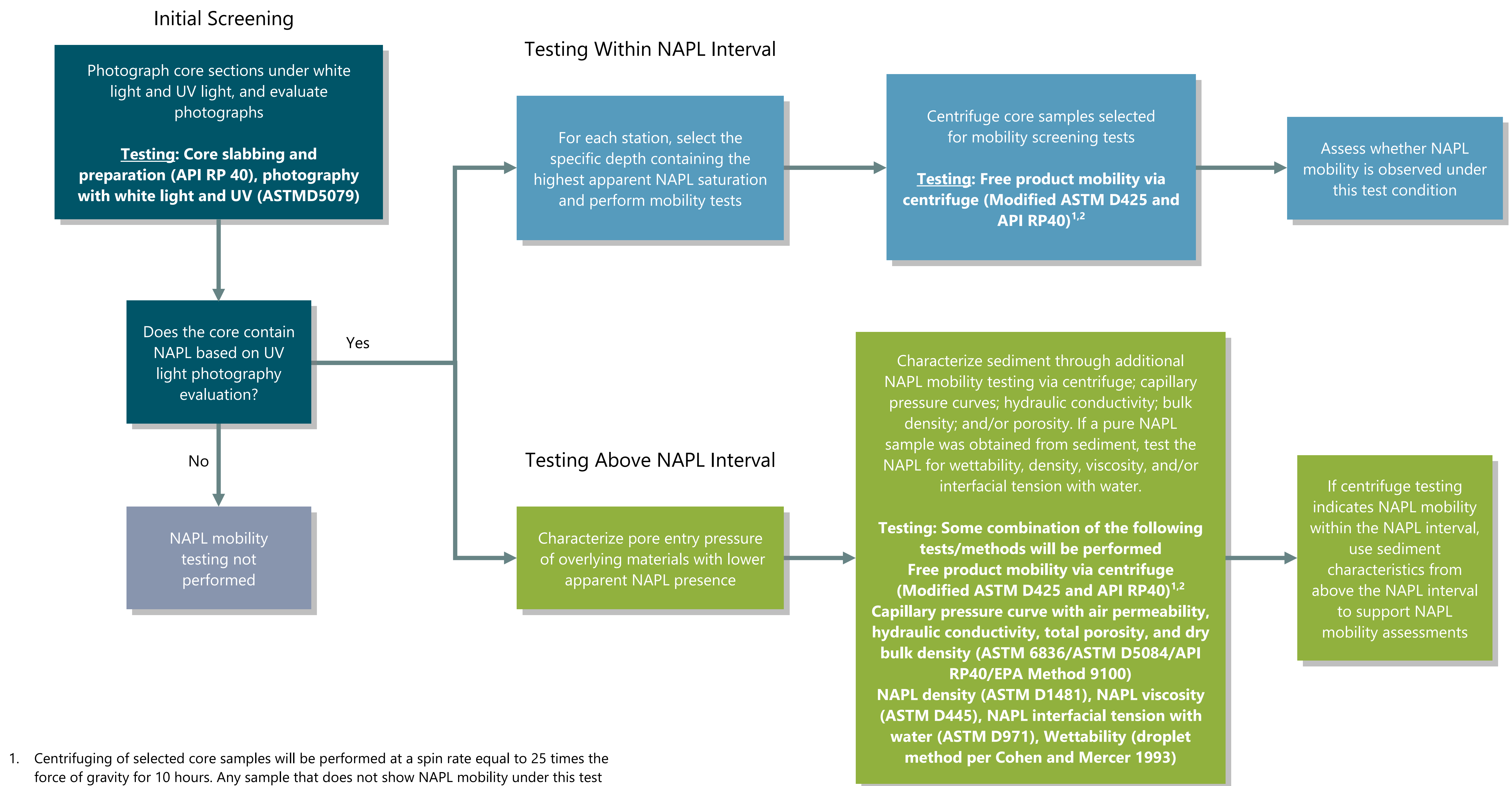
ANCHOR QEA

Figure 6
Proposed Subsurface Capping Demonstration Cores
Pre-Remedial Design Data Gaps Work Plan
Gasco Sediments Cleanup Action



1. Centrifuging of selected core samples will be performed at a spin rate equal to 25 times the force of gravity for 10 hours. Any sample that does not show NAPL mobility under this test condition indicates negligible NAPL hydraulic conductivity the order of 10^{-9} centimeters per second or less.
2. In addition to mobility testing, measurements will include initial and final pore fluid saturations, total porosity, specific gravity, and dry bulk density by API RP40.

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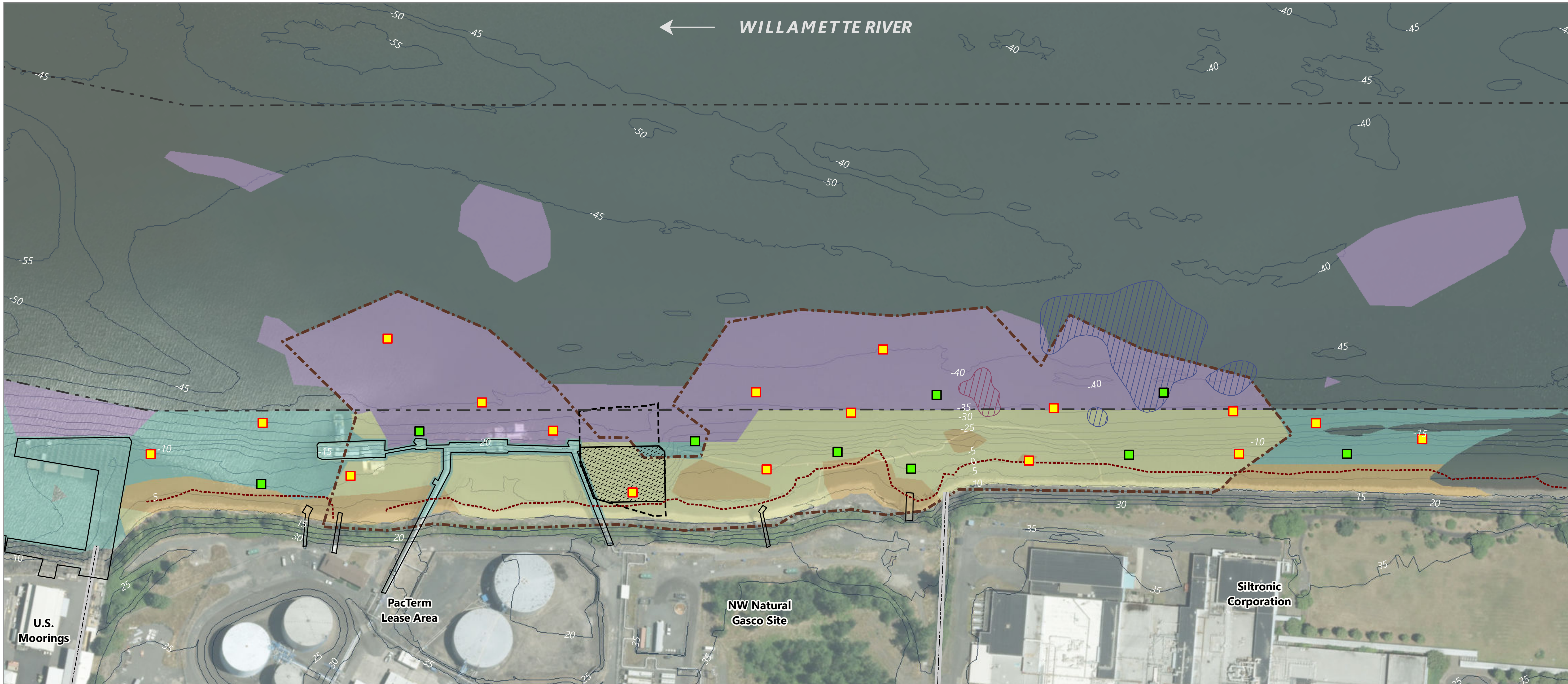
ANCHOR QEA

Figure 7
Staged NAPL Mobility Testing
Pre-Remedial Design Data Gaps Work Plan
Gasco Sediments Cleanup Action



LEGEND:

- Navigation Channel
- Structures
- Property Line
- Tar Body Removal Action Area (RAPP, Anchor 2005)
- Tar Body Removal Action Pilot Cap
- PTW-NAPL Boundary
- Elevation (feet COP)
- Approximate Riprap Boundary[1]

ROD SMA Technology[2]

- Cap
- Dredge
- Dredge in Nav-FMD
- Dredge with Cap
- 2010 Transition Zone Water Vinyl Chloride Area 1 Boundary (Anchor QEA 2012)[3]
- Area 2 – Detected CVOCs in TZW and One Subsurface Sediment Location[4]

- Proposed Sonic Core with Standard Penetration Test[5]
- Proposed In Situ Penetration Test[5]

NOTES:

1. Estimated from side scan sonar survey conducted by Blue Water Engineering April 2011.
2. All depicted SMA technology and PTW contours taken from the Portland Harbor Superfund Site Record of Decision (2017) without application of the EPA Explanation of Significant Differences (ESD; EPA 2018), which is not yet finalized.
3. Boundary taken from Draft Engineering Evaluation/Cost Analysis, Appendix A, Figure 4.2. Transition zone water screening level exceedances of cis-1,2-dichloroethene identified within this vinyl chloride boundary.
4. Boundary taken from Gasco Sediments Site Statement of Work, Figure 1 (EPA 2009).
5. The nearshore locations may be adjusted further toward of riverbank depending on the river elevations during sample collection if vessel access allows.
6. Bathymetry surveyed by DEA 2018. Topography surveyed by Geometrix 2011.
7. Arrow indicates direction of flow of river.
8. Horizontal datum is NAD83 (HARN 91) Oregon State Plane North, International Feet.
9. Vertical datum is City of Portland (COP), Feet.
10. Aerial imagery from City of Portland 2016.

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Figure 8
Proposed Geotechnical Explorations
Pre-Remedial Design Data Gaps Work Plan
Gasco Sediments Cleanup Action

LEGEND:

- Navigation Channel
- Structures
- Property Line
- Tar Body Removal Action Area (RAPP, Anchor 2005)
- Tar Body Removal Action Pilot Cap
- PTW-NAPL Boundary
- Elevation (feet COP)
- Approximate Riprap Boundary [1]

ROD SMA Technology [2]

- Cap
- Dredge
- Dredge in Nav-FMD
- Dredge with Cap
- 2010 Transition Zone Water Vinyl Chloride Area 1 Boundary (Anchor QEA 2012) [3]
- Area 2 – Detected CVOCs in TZW and One Subsurface Sediment Location [4]

- Extent of DNAPL Deemed Potentially Mobile Identified in Interim Feasibility Study (Anchor QEA 2018b; 0 to 12 feet)
- Extent of DNAPL Deemed Potentially Mobile Identified in Interim Feasibility Study (Anchor QEA 2018b; 12 to 22 feet)
- Existing Cores with Previously Observed PTW-NAPL
- Existing Subsurface Sample Location
- Proposed Angled Top of Riverbank Boring [5]

NOTES:

1. Estimated from side scan sonar survey conducted by Blue Water Engineering April 2011.
2. All depicted SMA technology and PTW contours taken from the Portland Harbor Superfund Site Record of Decision (2017) without application of the EPA Explanation of Significant Differences (ESD; EPA 2018), which is not yet finalized.
3. Boundary taken from Draft Engineering Evaluation/Cost Analysis, Appendix A, Figure 4.2. Transition zone water screening level exceedances of cis-1,2-dichloroethene identified within this vinyl chloride boundary.
4. Boundary taken from Gasco Sediments Site Statement of Work, Figure 1 (EPA 2009).
5. The locations may need to be adjusted in the field as necessary to facilitate equipment access.
6. Bathymetry surveyed by DEA 2018. Topography surveyed by Geometrix 2011.
7. Arrow indicates direction of flow of river.
8. Horizontal datum is NAD83 (HARN 91) Oregon State Plane North, International Feet.
9. Vertical datum is City of Portland (COP), Feet.
10. Aerial imagery from City of Portland 2016.

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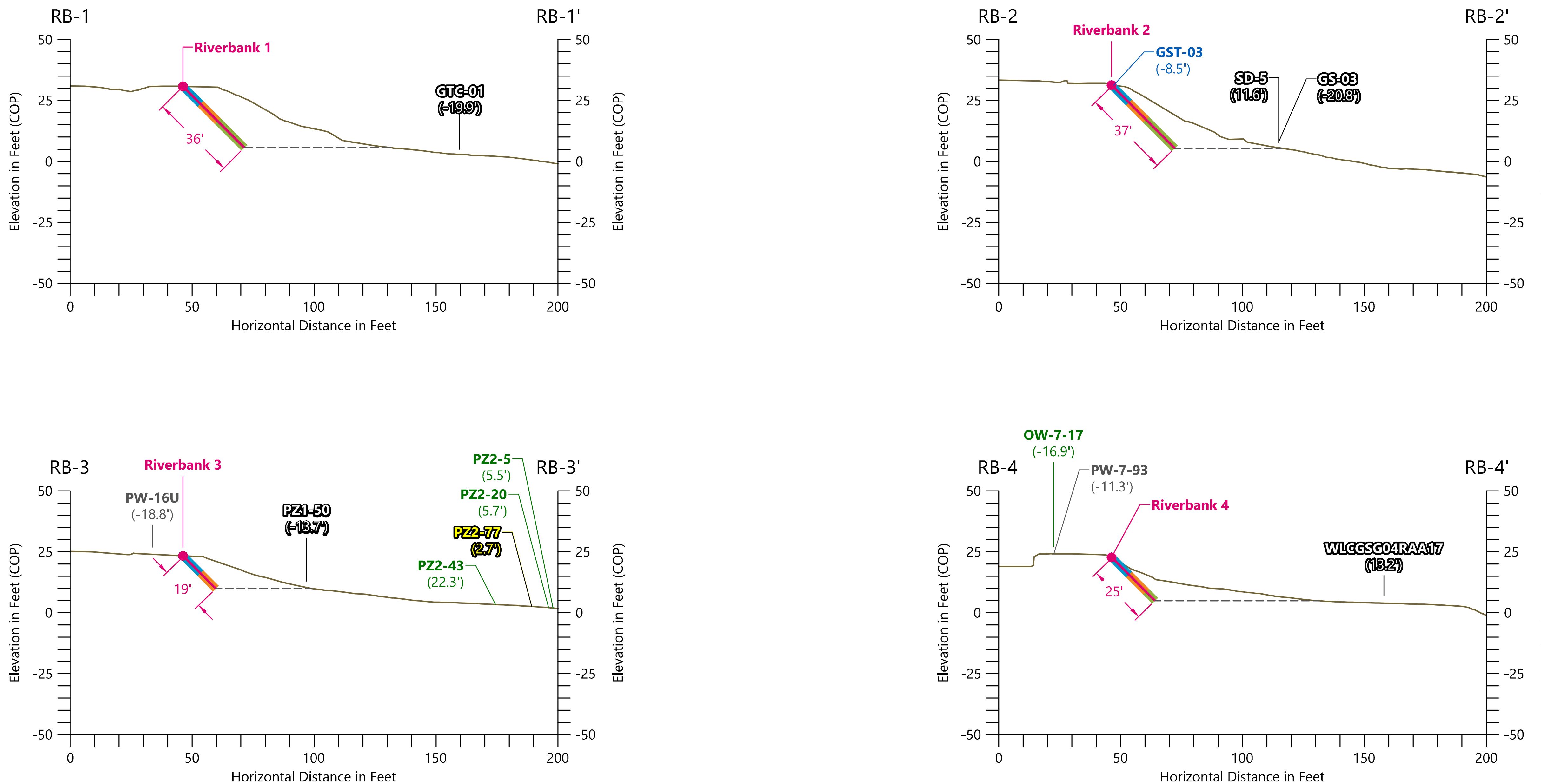
ANCHOR QEA

Figure 9
Proposed Angled Top of Riverbank Borings
Pre-Remedial Design Data Gaps Work Plan
Gasco Sediments Cleanup Action



LEGEND:

- Proposed Riverbank Core
- XX Existing Sediment/Riverbank Sample Location
- XX Existing Groundwater Monitoring Sample Location
- XX Existing Upland Sample Location
- XX Existing Core with Previously Observed PTW-NAPL
- XX Existing Core without Previously Observed PTW-NAPL
- (X.X') Offset Distance in Feet
- 0'-10' Sample Interval
- 10'-20' Sample Interval
- 20'-Bottom of Core Sample Interval

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Feet

HORIZONTAL DATUM: Oregon State Plane North, North American Datum of 1983 (NAD83/HARN 91), International Feet
VERTICAL DATUM: City of Portland (COP)
NOTE: Sampling will be performed at 0-3.5 feet, 3.5-12 feet, and 12 feet to remainder of length shown in each section above on a vertical basis. Actual sample lengths collected from each boring will be longer as a result of the boring being driven at an angle.

Publish Date: 2019/05/29 11:33 AM | User: hmerrick
Filepath: K:\Projects\0029-NW Natural Gas Co\Gasco Sediments_Pre-Remedial Design\Pre_RD Data Gaps SAP\0029-RP-004 (Sections).dwg Figure 10a

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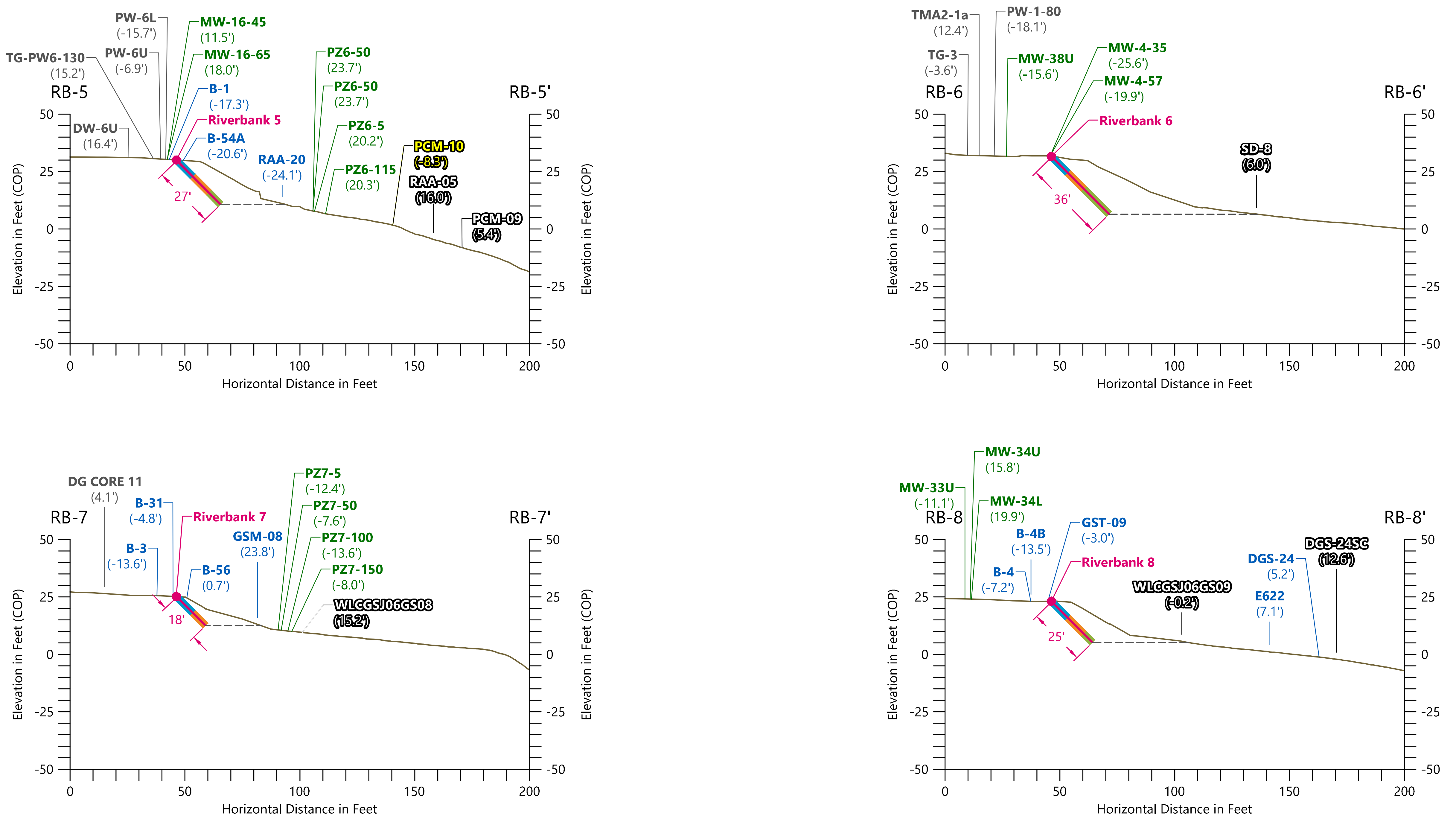
Figure 10a
Proposed Angled Top of Riverbank Borings – Riverbank Borings 1-4

Pre-Remedial Design Data Gaps Work Plan
Gasco Sediments Cleanup Action



LEGEND:

- Proposed Riverbank Core
- XX Existing Sediment/Riverbank Sample Location
- XX Existing Groundwater Monitoring Sample Location
- XX Existing Upland Sample Location
- XX Existing Core with Previously Observed PTW-NAPL
- XX Existing Core without Previously Observed PTW-NAPL
- (X.X') Offset Distance in Feet
- 0'-10' Sample Interval
- 10'-20' Sample Interval
- 20'-Bottom of Core Sample Interval

0 50 Feet

HORIZONTAL DATUM: Oregon State Plane North, North American Datum of 1983 (NAD83/HARN 91), International Feet
VERTICAL DATUM: City of Portland (COP)
NOTE: Sampling will be performed at 0-3.5 feet, 3.5-12 feet, and 12 feet to remainder of length shown in each section above on a vertical basis. Actual sample lengths collected from each boring will be longer as a result of the boring being driven at an angle.

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Filepath: K:\Projects\0029-NW Natural Gas Co\Gasco Sediments_Pre-Remedial Design\Pre_RD Data Gaps SAP\0029-RP-004 (Sections).dwg Figure 10b

ANCHOR QEA

Figure 10b
Proposed Angled Top of Riverbank Borings – Riverbank Borings 5-8

Pre-Remedial Design Data Gaps Work Plan
Gasco Sediments Cleanup Action

LEGEND:

- Navigation Channel
- Structures
- Property Line
- Tar Body Removal Action Area (RAPP, Anchor 2005)
- Tar Body Removal Action Pilot Cap
- PTW-NAPL Boundary
- Elevation (feet COP)
- Approximate Riprap Boundary[1]

ROD SMA Technology[2]

- Cap
- Dredge
- Dredge in Nav-FMD
- Dredge with Cap
- 2010 Transition Zone Water Vinyl Chloride Area 1 Boundary (Anchor QEA 2012)[3]
- Area 2 – Detected CVOCs in TZW and One Subsurface Sediment Location[4]

- Pre-RD Group Harborwide Monitoring Subsurface Sample Location (AECOM and Geosyntec 2018a)
- Existing Cores with Previously Observed PTW-NAPL
- Existing Subsurface Sample Location
- Barge Dewatering Treatment and Stabilization Evaluation Core

NOTES:
1. Estimated from side scan sonar survey conducted by Blue Water Engineering April 2011.
2. All depicted SMA technology and PTW contours taken from the Portland Harbor Superfund Site Record of Decision (2017) without application of the EPA Explanation of Significant Differences (ESD; EPA 2018), which is not yet finalized.
3. Boundary taken from Draft Engineering Evaluation/Cost Analysis, Appendix A, Figure 4.2. Transition zone water screening level exceedances of cis-1,2-dichloroethene identified within this vinyl chloride boundary.
4. Boundary taken from Gasco Sediments Site Statement of Work, Figure 1 (EPA 2009).
5. Bathymetry surveyed by DEA 2018. Topography surveyed by Geometrix 2011.
6. Arrow indicates direction of flow of river.
7. Horizontal datum is NAD83 (HARN 91) Oregon State Plane North, International Feet.
8. Vertical datum is City of Portland (COP), Feet.
9. Aerial imagery from City of Portland 2016.

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ANCHOR QEA

Figure 11
Proposed Dredge Material Barge Dewatering Treatment and Stabilization Evaluation Cores
Pre-Remedial Design Data Gaps Work Plan
Gasco Sediments Cleanup Action

LEGEND:

- Navigation Channel
- Structures
- Property Line
- Tar Body Removal Action Area (RAPP, Anchor 2005)
- Tar Body Removal Action Pilot Cap
- PTW-NAPL Boundary
- Elevation (feet COP)
- Approximate Riprap Boundary [1]

ROD SMA Technology[2]

- Cap
- Dredge
- Dredge in Nav-FMD
- Dredge with Cap
- 2010 Transition Zone Water Vinyl Chloride Area 1 Boundary (Anchor QEA 2012)[3]
- Area 2 – Detected CVOCs in TZW and One Subsurface Sediment Location[4]

- Pre-RD Group Harborwide Monitoring Subsurface Sample Location (AECOM and Geosyntec 2018a)
- Existing Cores with Previously Observed PTW-NAPL
- Existing Subsurface Sample Location
- Existing TCLP Location
- Proposed TCLP/RBC Location

NOTES:

1. Estimated from side scan sonar survey conducted by Blue Water Engineering April 2011.
2. All depicted SMA technology and PTW contours taken from the Portland Harbor Superfund Site Record of Decision (2017) without application of the EPA Explanation of Significant Differences (ESD; EPA 2018), which is not yet finalized.
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4. Boundary taken from Gasco Sediments Site Statement of Work, Figure 1 (EPA 2009).
5. Bathymetry surveyed by DEA 2018. Topography surveyed by Geometrix 2011.
6. Arrow indicates direction of flow of river.
7. Horizontal datum is NAD83 (HARN 91) Oregon State Plane North, International Feet.
8. Vertical datum is City of Portland (COP), Feet.
9. Aerial imagery from City of Portland 2016.

TCLP: toxicity characteristic leaching procedure
RBC: risk-based concentration

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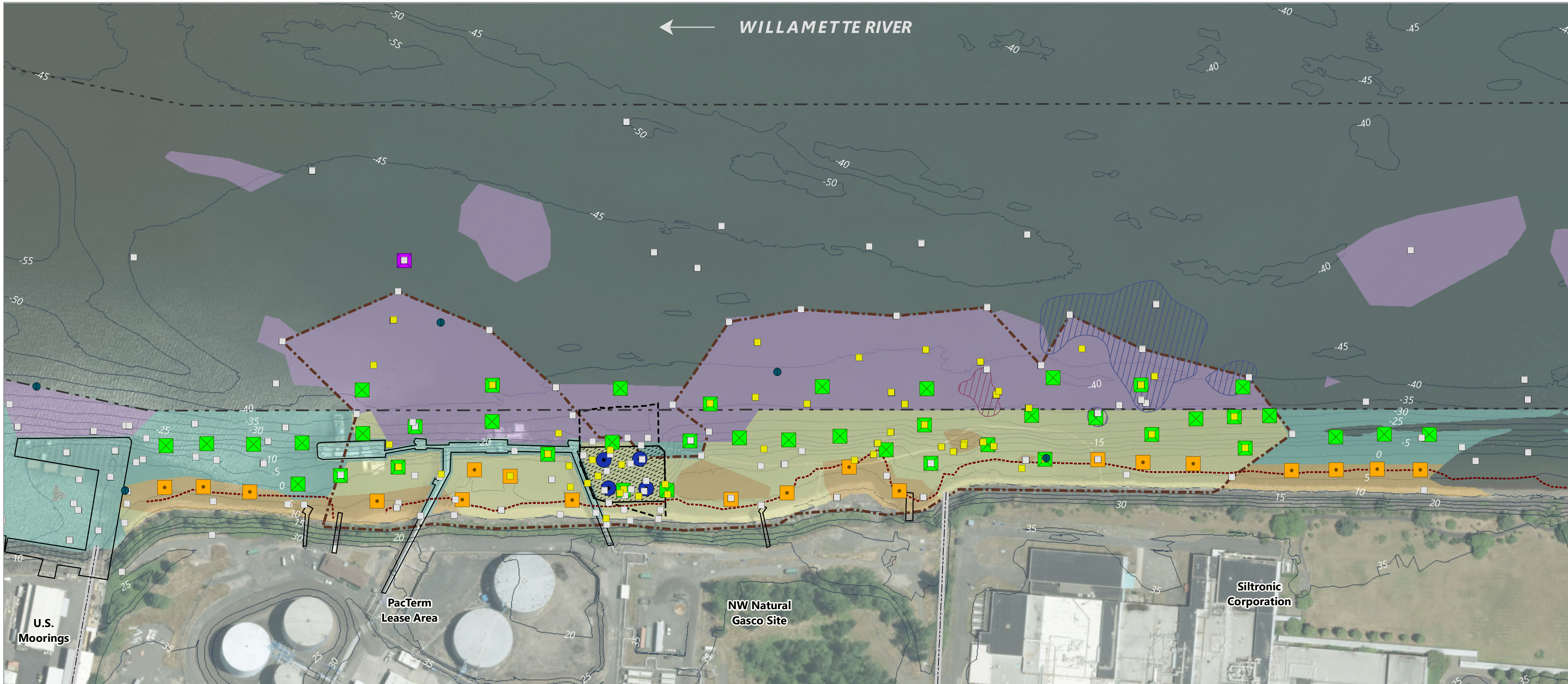
ANCHOR QEA

Figure 12
Proposed Dredge Material Waste Suitability Characterization Cores

Pre-Remedial Design Data Gaps Work Plan
Gasco Sediments Cleanup Action



LEGEND:

- Navigation Channel
- Structures
- Property Line
- Tar Body Removal Action Area (RAPP, Anchor 2005)
- Tar Body Removal Action Pilot Cap
- PTW-NAPL Boundary
- Elevation (feet COP)
- Approximate Riprap Boundary [1]

ROD SMA Technology[2]

- Cap
- Dredge
- Dredge in Nav-FMD
- Dredge with Cap
- 2010 Transition Zone Water Vinyl Chloride Area 1 Boundary (Anchor QEA 2012)[3]
- Area 2 – Detected CVOCs in TZW and One Subsurface Sediment Location[4]

- Pre-RD Group Harborwide Monitoring Subsurface Sample Location (AECOM and Geosyntec 2018a)
- Existing Cores with Previously Observed PTW-NAPL
- Existing Subsurface Sample Location

Proposed Additional Analyses Locations

- 0-1 ft
- 0-2 ft, 2-4 ft, 4-6 ft, and 6-8 ft
- 0-2 ft, 2-5 ft, and 5-7 ft[5]
- 1-2 ft, 2-3 ft, and 3-4 ft

NOTES:

1. Estimated from side scan sonar survey conducted by Blue Water Engineering April 2011.
2. All depicted SMA technology and PTW contours taken from the Portland Harbor Superfund Site Record of Decision (2017) without application of the EPA Explanation of Significant Differences (ESD; EPA 2018), which is not yet finalized.
3. Boundary taken from Draft Engineering Evaluation/Cost Analysis, Appendix A, Figure 4.2. Transition zone water screening level exceedances of cis-1,2-dichloroethene identified within this vinyl chloride boundary.
4. Boundary taken from Gasco Sediments Site Statement of Work, Figure 1 (EPA 2009).
5. The nearshore core locations may need to be adjusted further offshore depending on the river elevations during sample collection to facilitate vessel access.
6. Bathymetry surveyed by DEA 2018. Topography surveyed by Geometrix 2011.
7. Arrow indicates direction of flow of river.
8. Horizontal datum is NAD83 (HARN 91) Oregon State Plane North, International Feet.
9. Vertical datum is City of Portland (COP), Feet.
10. Aerial imagery from City of Portland 2016.

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Figure 13
Proposed Additional Analyses Locations for Non-Site-Specific COCs
Pre-Remedial Design Data Gaps Work Plan
Gasco Sediments Cleanup Action

Attachment B

DGWP Appendix A Updated Tables

Table A-1
Surface Sediment Sampling Locations

Sample Location	Purpose	Easting (X)	Northing (Y)
PDI-002	Interim Project Area Verification	7623560.18	706107.22
PDI-003	Interim Project Area Verification	7623644.48	706135.27
PDI-010	Interim Project Area Verification	7623834.35	705981.28
PDI-089	Interim Project Area Verification	7625261.85	705067.23
PDI-018	Additional Surface Sediment Data Density	7624449.12	705679.00
PDI-020	Additional Surface Sediment Data Density	7624519.86	705614.74
PDI-022	Additional Surface Sediment Data Density	7624574.36	705465.54
PDI-023	Additional Surface Sediment Data Density	7624612.41	705532.39
PDI-090	Recent Deposition Interim Action Area	7623937.76	705620.25
PDI-091	Recent Deposition Interim Action Area	7623958.77	705672.69
PDI-092	Recent Deposition Interim Action Area	7624000.68	705581.74
PDI-093	Recent Deposition Interim Action Area	7624019.85	705638.09

Note:
Coordinates are in North American Datum of 1983 (HARN91) Oregon State Plane North, International Feet.

Table A-2
Riverbank Angled Boring Sampling Location and Depth Intervals

Boring ID	Easting (X)[1]	Northing (Y)[1]	0 to 10 Feet	10 to 20 Feet	20 Feet to Bottom Depth	Bottom Depth[2] (bgs)	Approximate Boring Length[3] (feet)
PDI-120	7623170.91	705962.45	X	X	X	25.5	36
PDI-121	7623362.12	705848.62	X	X	X	26.2	37
PDI-122	7623577.90	705712.55	X	X		13.4	19
PDI-123	7623780.17	705605.00	X	X	X	17.7	25
PDI-124	7623937.19	705492.16	X	X	X	19.1	27
PDI-125	7624124.85	705365.50	X	X	X	25.5	36
PDI-126	7624270.77	705335.08	X	X		12.7	18
PDI-127	7624429.01	705238.11	X	X	X	17.7	25

Notes:
1. Coordinates are in North American Datum of 1983 (HARN91) Oregon State Plane North, International Feet.
2. Bottom depths were determined through the identification of the nearest offshore subsurface sampling location.
3. The approximate boring length was made using an entry angle of 45 degrees.
bgs: below ground surface

Table A-3
Subsurface Sediment Sampling Locations

Sediment Core Location	Easting (X)	Northing (Y)	Sampling Program									
				Cap Modelling							Additional Analysis	
			DOC[1]	Dredge and Cap or Capping Only Nearshore[2]	Dredge and Cap or Capping Only Offshore[3]	Waste Characterization[4]	Barge Dewatering (Dredge Elutriate)[4]	Porewater[5]	Biogas Generation Potential	NAPL Mobility	Nearshore[6]	Offshore[7]
PDI-001	7623533.10	706219.53	X	--	X	--	--	--	--	To be determined based on field observations of PTW-NAPL presence	--	--
PDI-002	7623560.18	706107.22	X	--	X	--	--	--	--		--	--
PDI-003	7623644.48	706135.27	X	--	X	X	X	--	--		--	--
PDI-004	7623622.57	706034.88	X	--	X	--	--	--	--		--	X
PDI-005	7623746.00	706121.00	X	--	X	--	--	--	--		--	--
PDI-006	7623782.65	706164.42	X	--	X	--	--	--	--		--	--
PDI-007	7623732.32	706037.75	X	--	X	--	--	--	--		--	--
PDI-008	7623727.46	705958.91	X	--	X	--	--	--	--		--	--
PDI-009	7623822.88	706067.97	X	--	X	--	--	--	--		--	--
PDI-010	7623834.35	705981.28	X	--	X	X	X	--	--		--	--
PDI-011	7623846.55	705910.83	X	--	X	--	--	--	--		--	X
PDI-012	7624058.78	705776.51	X	--	X	--	--	--	--		--	X
PDI-013	7624182.64	705719.51	X	--	X	--	--	--	--		--	--
PDI-014	7624194.63	705658.78	X	--	X	X	X	--	--		--	X
PDI-015	7624276.47	705622.55	X	--	X	--	--	--	--		--	--
PDI-016	7624336.00	705715.00	X	--	X	--	--	--	--		--	--
PDI-017	7624339.80	705645.22	X	--	X	--	--	--	--		--	--
PDI-018	7624449.12	705679.00	X	--	X	--	--	--	--		--	--
PDI-019	7624400.68	705574.66	X	--	X	X	X	--	--		--	X
PDI-020	7624519.86	705614.74	X	--	X	--	--	--	--		--	--
PDI-021	7624487.54	705512.82	X	--	X	--	--	--	--		--	--
PDI-022	7624574.36	705465.54	X	--	X	--	--	--	--		--	X
PDI-023	7624612.41	705532.39	X	--	X	X	X	--	--		--	--
PDI-024	7624634.30	705573.75	X	--	X	--	--	--	--		--	--
PDI-025	7624677.80	705388.29	X	--	X	X	X	X	--		--	--
PDI-026	7624692.32	705455.24	X	--	X	--	--	--	--		--	--
PDI-027	7624722.96	705524.69	X	--	X	--	--	--	--		--	--
PDI-028	7624778.23	705455.43	X	--	X	--	--	--	--		--	--
PDI-029	7624798.16	705356.24	X	--	X	--	--	--	--		--	X
PDI-030	7624882.60	705414.65	X	--	X	--	--	--	--		--	--
PDI-031	7624880.60	705324.69	X	--	X	--	--	--	--		--	--
PDI-032	7624942.72	705317.03	X	--	X	--	--	--	--		--	--
PDI-033	7624939.00	705255.00	X	--	X	--	--	X	--		--	X
PDI-034	7625017.10	705226.76	X	--	X	--	--	--	--		--	--
PDI-035	7625108.29	705149.31	X	--	X	--	--	--	--		--	X
PDI-036	7623499.23	705913.12	X	--	X	--	--	--	--		--	X
PDI-037	7623579.52	705961.29	X	--	X	--	--	--	X		--	X
PDI-038	7623535.35	705833.15	X	X	--	--	--	--	--		X	--

Table A-3
Subsurface Sediment Sampling Locations

Sediment Core Location	Easting (X)	Northing (Y)	Sampling Program									
				Cap Modelling							Additional Analysis	
			DOC[1]	Dredge and Cap or Capping Only Nearshore[2]	Dredge and Cap or Capping Only Offshore[3]	Waste Characterization[4]	Barge Dewatering (Dredge Elutriate)[4]	Porewater[5]	Biogas Generation Potential	NAPL Mobility	Nearshore[6]	Offshore[7]
PDI-039	7623605.33	705868.80	X	--	X	X	X	--	X	To be determined based on field observations of PTW-NAPL presence	--	X
PDI-040	7623674.61	705919.44	X	--	X	--	--	X	--		--	X
PDI-041	7623679.76	705748.94	X	X	--	--	--	--	--		X	--
PDI-042	7623730.57	705787.21	X	X	--	--	--	--	--		X	--
PDI-043	7623809.25	705849.87	X	--	X	--	--	X	--		--	X
PDI-044	7623784.26	705739.68	X	X	--	--	--	--	X		X	--
PDI-045	7623869.88	705739.20	X	--	X	--	--	--	--		--	X
PDI-046	7623864.68	705637.51	X	X	--	X	X	--	--		X	--
PDI-047	7623990.97	705693.89	X	--	X	--	--	X	X		--	X
PDI-048	7623961.15	705601.58	X	--	X	X	X	--	--		--	X
PDI-049	7624034.02	705558.07	X	--	X	--	--	--	--		--	X
PDI-050	7624122.98	705617.65	X	--	X	--	--	X	--		--	X
PDI-051	7624132.65	705477.49	X	X	--	--	--	--	X		X	--
PDI-052	7624209.09	705572.39	X	--	X	--	--	--	--		--	X
PDI-053	7624234.01	705431.95	X	X	--	--	--	--	--		X	--
PDI-054	7624290.22	705518.89	X	--	X	--	--	X	X		--	X
PDI-055	7624379.88	705473.57	X	--	X	--	--	X	--		--	X
PDI-056	7624364.42	705412.59	X	X	--	--	--	--	--		X	--
PDI-057	7624443.91	705404.10	X	--	X	--	--	--	--		--	X
PDI-058	7624424.91	705321.44	X	X	--	--	--	--	--		X	--
PDI-059	7624534.00	705407.00	X	--	X	--	--	--	X		--	X
PDI-060	7624505.92	705335.97	X	--	X	--	--	X	--		--	X
PDI-061	7624620.76	705309.50	X	--	X	--	--	--	--		--	X
PDI-062	7624724.03	705314.15	X	--	X	X	X	X	--		--	X
PDI-063	7624702.05	705227.69	X	--	X	--	--	--	--		--	X
PDI-064	7624791.00	705173.00	X	X	--	--	--	--	--		X	--
PDI-065	7624829.76	705245.29	X	--	X	--	--	X	--		--	X
PDI-066	7624864.35	705123.10	X	X	--	--	--	--	--		X	--
PDI-067	7624907.00	705161.00	X	--	X	--	--	--	X		--	X
PDI-068	7624947.58	705070.03	X	X	--	X	X	--	--		X	--
PDI-069	7624996.86	705142.77	X	--	X	--	--	X	--		--	X
PDI-070	7625063.58	705107.51	X	--	X	--	--	--	--		--	X
PDI-071	7625050.31	705043.44	X	--	X	--	--	--	--		--	X
PDI-072	7625124.24	705073.44	X	--	X	--	--	--	X		--	X
PDI-073	7623190.93	706070.85	--	X	--	--	--	--	--		X	--
PDI-074	7623235.47	706139.59	--	--	X	--	--	--	--		--	X
PDI-075	7623257.06	706032.73	--	X	--	--	--	--	--		X	--
PDI-076	7623306.60	706101.71	--	--	X	--	--	--	--		--	X
PDI-077	7623330.06	705976.90	--	X	--	--	--	--	--		X	--

Table A-3
Subsurface Sediment Sampling Locations

Sediment Core Location	Easting (X)	Northing (Y)	Sampling Program									
				Cap Modelling							Additional Analysis	
			DOC[1]	Dredge and Cap or Capping Only Nearshore[2]	Dredge and Cap or Capping Only Offshore[3]	Waste Characterization[4]	Barge Dewatering (Dredge Elutriate)[4]	Porewater[5]	Biogas Generation Potential	NAPL Mobility	Nearshore[6]	Offshore[7]
PDI-078	7623384.38	706053.36	--	--	X	--	--	--	X	To be determined based on field observations of PTW-NAPL presence	--	X
PDI-079	7623419.29	705941.73	--	--	X	--	--	--	--		--	X
PDI-080	7623467.87	706006.42	--	--	X	--	--	--	--		--	X
PDI-081	7625106.30	704958.83	--	X	--	--	--	--	--		X	--
PDI-082	7625181.95	704914.99	--	X	--	--	--	--	--		X	--
PDI-083	7625214.39	704970.87	--	--	X	--	--	--	--		--	X
PDI-084	7625251.64	704874.73	--	X	--	--	--	--	--		X	--
PDI-085	7625298.78	704926.71	--	--	X	X	X	--	--		--	X
PDI-086	7625323.48	704829.95	--	X	--	--	--	--	--		X	--
PDI-087	7625374.67	704880.13	--	--	X	--	--	--	--		--	X
PDI-088	7623824.13	706209.79	--	--	--	--	--	--	--		--	X

Notes:
Coordinates are in North American Datum of 1983 (HARN91) Oregon State Plane North, International Feet.
1. Sampling intervals for DOC cores start at two successive intervals from the bottom depth of recovery toward the mudline. Remaining intervals will be archived in 1-foot intervals.
2. Sampling intervals for nearshore dredge and cap or capping-only cores are 0 to 2 feet, 2 to 5 feet, 5 to 7 feet, 7 to 10 feet, and 10 to 13 feet below mudline. Potentially deeper samples will be collected if PTW-NAPL is identified.
3. Sampling intervals for offshore dredge and cap or capping only cores outside the navigation channel are consecutive 2-foot intervals throughout core penetration. Sampling intervals for offshore dredge and cap cores inside the navigational channel are consecutive 2-foot intervals throughout the penetration depth starting at -47 feet COP elevation.
4. Waste characterization and barge dewatering samples will be collected from one vertically composited from existing mudline to the DOC, which will be estimated based on visual and olfactory indications of contamination.
5. Porewater samples will be collected from 4 to 6 feet below mudline.
6. Sampling intervals for nearshore additional analysis cores are 0 to 2 feet, 2 to 5 feet, and 5 to 7 feet below mudline.
7. Sampling intervals for offshore additional analysis cores are 0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline.
COP: City of Portland datum
DOC: depth of contamination
NAPL: nonaqueous phase liquid
PTW: principal threat waste

Table A-4
Subsurface Sediment Sampling Intervals

Sediment Core Location	Sampling Program									
		Cap Modelling							Additional Analysis	
	DOC[1]	Dredge and Cap or Capping Only Nearshore[2]	Dredge and Cap or Capping Only Offshore[3]	Waste Characterization[4]	Barge Dewatering (Dredge Elutriate)[4]	Porewater[5]	Biogas Generation Potential	NAPL Mobility	Nearshore	Offshore
PDI-001	Two consecutive 1-foot intervals from bottom depth of recovery, 1-foot samples (archive) above those samples to mudline	--	Consecutive 2-foot intervals throughout core penetration depth starting at -47 feet COP elevation	--	--	--	--	To be determined based on field observations of PTW-NAPL presence	--	--
PDI-002		--		--	--	--	--		--	--
PDI-003		--		Vertical composite from mudline to DOC	Vertical composite from mudline to DOC	--	--		--	--
PDI-004		--		--	--	--	--		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline
PDI-005		--		--	--	--	--		--	--
PDI-006		--		--	--	--	--		--	--
PDI-007		--		--	--	--	--		--	--
PDI-008		--		--	--	--	--		--	--
PDI-009		--		--	--	--	--		--	--
PDI-010		--		Vertical composite from mudline to DOC	Vertical composite from mudline to DOC	--	--		--	--
PDI-011		--		--	--	--	--		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline
PDI-012		--		--	--	--	--		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline
PDI-013		--		--	--	--	--		--	--
PDI-014		--		Vertical composite from mudline to DOC	Vertical composite from mudline to DOC	--	--		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline
PDI-015		--		--	--	--	--		--	--
PDI-016		--		--	--	--	--		--	--
PDI-017		--		--	--	--	--		--	--
PDI-018		--		--	--	--	--		--	--
PDI-019		--		Vertical composite from mudline to DOC	Vertical composite from mudline to DOC	--	--		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline
PDI-020		--		--	--	--	--		--	--
PDI-021		--		--	--	--	--		--	--
PDI-022		--		--	--	--	--		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline
PDI-023		--		Vertical composite from mudline to DOC	Vertical composite from mudline to DOC	--	--		--	--
PDI-024		--		--	--	--	--		--	--

Table A-4
Subsurface Sediment Sampling Intervals

Sediment Core Location	Sampling Program									
	DOC[1]	Cap Modelling: Dredge and Cap or Capping Only Nearshore[2]	Cap Modelling: Dredge and Cap or Capping Only Offshore[3]	Waste Characterization[4]	Barge Dewatering (Dredge Elutriate)[4]	Porewater[5]	Biogas Generation Potential	NAPL Mobility	Additional Analysis: Nearshore	Additional Analysis: Offshore
PDI-025	Two consecutive 1-foot intervals from bottom depth of recovery, 1-foot samples (archive) above those samples to mudline	--	Consecutive 2-foot intervals throughout core penetration depth starting at -47 feet COP elevation	Vertical composite from mudline to DOC	Vertical composite from mudline to DOC	4 to 6 feet below mudline	--	To be determined based on field observations of PTW-NAPL presence	--	--
PDI-026		--		--	--	--	--		--	--
PDI-027		--		--	--	--	--		--	--
PDI-028		--		--	--	--	--		--	--
PDI-029		--		--	--	--	--		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline
PDI-030		--		--	--	--	--		--	--
PDI-031		--		--	--	--	--		--	--
PDI-032		--		--	--	--	--		--	--
PDI-033		--		--	--	4 to 6 feet below mudline	--		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline
PDI-034		--		--	--	--	--		--	--
PDI-035		--		--	--	--	--		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline
PDI-036		--	Consecutive 2-foot intervals throughout core penetration depth	--	--	--	--		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline
PDI-037		--	Consecutive 2-foot intervals throughout core penetration depth	--	--	--	6 to 8 feet below mudline		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline
PDI-038		0- to 2-foot, 2- to 5-foot, 5- to 7-foot, 7- to 10-foot, and 10- to 13-foot intervals	--	--	--	--	--		0 to 2 feet, 2 to 5 feet, and 5 to 7 feet below mudline	--
PDI-039		--	Consecutive 2-foot intervals throughout core penetration depth	Vertical composite from mudline to DOC	Vertical composite from mudline to DOC	--	6 to 8 feet below mudline		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline
PDI-040		--	Consecutive 2-foot intervals throughout core penetration depth	--	--	4 to 6 feet below mudline	--		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline

Table A-4
Subsurface Sediment Sampling Intervals

Sediment Core Location	Sampling Program									
	DOC[1]	Cap Modelling		Waste Characterization[4]	Barge Dewatering (Dredge Elutriate)[4]	Porewater[5]	Biogas Generation Potential	NAPL Mobility	Additional Analysis	
		Dredge and Cap or Capping Only Nearshore[2]	Dredge and Cap or Capping Only Offshore[3]						Nearshore	Offshore
PDI-041	Two consecutive 1-foot intervals from bottom depth of recovery, 1-foot samples (archive) above those samples to mudline	0- to 2-foot, 2- to 5-foot, 5- to 7-foot, 7- to 10-foot, and 10- to 13-foot intervals	--	--	--	--	--	To be determined based on field observations of PTW-NAPL presence	0 to 2 feet, 2 to 5 feet, and 5 to 7 feet below mudline	--
PDI-042		0- to 2-foot, 2- to 5-foot, 5- to 7-foot, 7- to 10-foot, and 10- to 13-foot intervals	--	--	--	--	--		0 to 2 feet, 2 to 5 feet, and 5 to 7 feet below mudline	--
PDI-043		--	Consecutive 2-foot intervals throughout core penetration depth	--	--	4 to 6 feet below mudline	--		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline
PDI-044		0- to 2-foot, 2- to 5-foot, 5- to 7-foot, 7- to 10-foot, and 10- to 13-foot intervals	--	--	--	--	5 to 7 feet below mudline		0 to 2 feet, 2 to 5 feet, and 5 to 7 feet below mudline	--
PDI-045		--	Consecutive 2-foot intervals throughout core penetration depth	--	--	--	--		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline
PDI-046		0- to 2-foot, 2- to 5-foot, 5- to 7-foot, 7- to 10-foot, and 10- to 13-foot intervals	--	Vertical composite from mudline to DOC	Vertical composite from mudline to DOC	--	--		0 to 2 feet, 2 to 5 feet, and 5 to 7 feet below mudline	--
PDI-047		--	Consecutive 2-foot intervals throughout core penetration depth	--	--	4 to 6 feet below mudline	6 to 8 feet below mudline		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline
PDI-048		--	Consecutive 2-foot intervals throughout core penetration depth	Vertical composite from mudline to DOC	Vertical composite from mudline to DOC	--	--		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline
PDI-049		--	Consecutive 2-foot intervals throughout core penetration depth	--	--	--	--		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline

Table A-4
Subsurface Sediment Sampling Intervals

Sediment Core Location	Sampling Program									
	DOC[1]	Cap Modelling: Dredge and Cap or Capping Only Nearshore[2]	Cap Modelling: Dredge and Cap or Capping Only Offshore[3]	Waste Characterization[4]	Barge Dewatering (Dredge Elutriate)[4]	Porewater[5]	Biogas Generation Potential	NAPL Mobility	Additional Analysis: Nearshore	Additional Analysis: Offshore
PDI-050	Two consecutive 1-foot intervals from bottom depth of recovery, 1-foot samples (archive) above those samples to mudline	--	Consecutive 2-foot intervals throughout core penetration depth	--	--	4 to 6 feet below mudline	--	To be determined based on field observations of PTW-NAPL presence	--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline
PDI-051		0- to 2-foot, 2- to 5-foot, 5- to 7-foot, 7- to 10-foot, and 10- to 13-foot intervals	--	--	--	--	5 to 7 feet below mudline		0 to 2 feet, 2 to 5 feet, and 5 to 7 feet below mudline	--
PDI-052		--	Consecutive 2-foot intervals throughout core penetration depth	--	--	--	--		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline
PDI-053		0- to 2-foot, 2- to 5-foot, 5- to 7-foot, 7- to 10-foot, and 10- to 13-foot intervals	--	--	--	--	--		0 to 2 feet, 2 to 5 feet, and 5 to 7 feet below mudline	--
PDI-054		--	Consecutive 2-foot intervals throughout core penetration depth	--	--	4 to 6 feet below mudline	6 to 8 feet below mudline		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline
PDI-055		--	Consecutive 2-foot intervals throughout core penetration depth	--	--	4 to 6 feet below mudline	--		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline
PDI-056		0- to 2-foot, 2- to 5-foot, 5- to 7-foot, 7- to 10-foot, and 10- to 13-foot intervals	--	--	--	--	--		0 to 2 feet, 2 to 5 feet, and 5 to 7 feet below mudline	--
PDI-057		--	Consecutive 2-foot intervals throughout core penetration depth	--	--	--	--		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline
PDI-058		0- to 2-foot, 2- to 5-foot, 5- to 7-foot, 7- to 10-foot, and 10- to 13-foot intervals	--	--	--	--	--		0 to 2 feet, 2 to 5 feet, and 5 to 7 feet below mudline	--

Table A-4
Subsurface Sediment Sampling Intervals

Sediment Core Location	Sampling Program									
		Cap Modelling							Additional Analysis	
	DOC[1]	Dredge and Cap or Capping Only Nearshore[2]	Dredge and Cap or Capping Only Offshore[3]	Waste Characterization[4]	Barge Dewatering (Dredge Elutriate)[4]	Porewater[5]	Biogas Generation Potential	NAPL Mobility	Nearshore	Offshore
PDI-059	Two consecutive 1-foot intervals from bottom depth of recovery, 1-foot samples (archive) above those samples to mudline	--	Consecutive 2-foot intervals throughout core penetration depth	--	--	--	6 to 8 feet below mudline	To be determined based on field observations of PTW-NAPL presence	--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline
PDI-060		--	Consecutive 2-foot intervals throughout core penetration depth	--	--	4 to 6 feet below mudline	--		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline
PDI-061		--	Consecutive 2-foot intervals throughout core penetration depth	--	--	--	--		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline
PDI-062		--	Consecutive 2-foot intervals throughout core penetration depth	Vertical composite from mudline to DOC	Vertical composite from mudline to DOC	4 to 6 feet below mudline	--		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline
PDI-063		--	Consecutive 2-foot intervals throughout core penetration depth	--	--	--	--		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline
PDI-064		0- to 2-foot, 2- to 5-foot, 5- to 7-foot, 7- to 10-foot, and 10- to 13-foot intervals	--	--	--	--	--		0 to 2 feet, 2 to 5 feet, and 5 to 7 feet below mudline	--
PDI-065		--	Consecutive 2-foot intervals throughout core penetration depth	--	--	4 to 6 feet below mudline	--		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline
PDI-066		0- to 2-foot, 2- to 5-foot, 5- to 7-foot, 7- to 10-foot, and 10- to 13-foot intervals	--	--	--	--	--		0 to 2 feet, 2 to 5 feet, and 5 to 7 feet below mudline	--
PDI-067		--	Consecutive 2-foot intervals throughout core penetration depth	--	--	--	6 to 8 feet below mudline		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline

Table A-4
Subsurface Sediment Sampling Intervals

Sediment Core Location	Sampling Program									
		Cap Modelling							Additional Analysis	
	DOC[1]	Dredge and Cap or Capping Only Nearshore[2]	Dredge and Cap or Capping Only Offshore[3]	Waste Characterization[4]	Barge Dewatering (Dredge Elutriate)[4]	Porewater[5]	Biogas Generation Potential	NAPL Mobility	Nearshore	Offshore
PDI-068	Two consecutive 1-foot intervals from bottom depth of recovery, 1-foot samples (archive) above those samples to mudline	0- to 2-foot, 2- to 5-foot, 5- to 7-foot, 7- to 10-foot, and 10- to 13-foot intervals	--	Vertical composite from mudline to DOC	Vertical composite from mudline to DOC	--	--	To be determined based on field observations of PTW-NAPL presence	0 to 2 feet, 2 to 5 feet, and 5 to 7 feet below mudline	--
PDI-069		--	Consecutive 2-foot intervals throughout core penetration depth	--	--	4 to 6 feet below mudline	--		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline
PDI-070		--	Consecutive 2-foot intervals throughout core penetration depth	--	--	--	--		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline
PDI-071		--	Consecutive 2-foot intervals throughout core penetration depth	--	--	--	--		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline
PDI-072		--	Consecutive 2-foot intervals throughout core penetration depth	--	--	--	6 to 8 feet below mudline		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline
PDI-073	--	0- to 2-foot, 2- to 5-foot, 5- to 7-foot, 7- to 10-foot, and 10- to 13-foot intervals	--	--	--	--	--		0 to 2 feet, 2 to 5 feet, and 5 to 7 feet below mudline	--
PDI-074	--	--	Consecutive 2-foot intervals throughout core penetration depth	--	--	--	--		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline
PDI-075	--	0- to 2-foot, 2- to 5-foot, 5- to 7-foot, 7- to 10-foot, and 10- to 13-foot intervals	--	--	--	--	--		0 to 2 feet, 2 to 5 feet, and 5 to 7 feet below mudline	--
PDI-076	--	--	Consecutive 2-foot intervals throughout core penetration depth	--	--	--	--		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline

Table A-4
Subsurface Sediment Sampling Intervals

Sediment Core Location	Sampling Program									
	DOC[1]	Cap Modelling		Waste Characterization[4]	Barge Dewatering (Dredge Elutriate)[4]	Porewater[5]	Biogas Generation Potential	NAPL Mobility	Additional Analysis	
		Dredge and Cap or Capping Only Nearshore[2]	Dredge and Cap or Capping Only Offshore[3]						Nearshore	Offshore
PDI-077	--	0- to 2-foot, 2- to 5-foot, 5- to 7-foot, 7- to 10-foot, and 10- to 13-foot intervals	--	--	--	--	--	To be determined based on field observations of PTW-NAPL presence	0 to 2 feet, 2 to 5 feet, and 5 to 7 feet below mudline	--
PDI-078	--	--	Consecutive 2-foot intervals throughout core penetration depth	--	--	--	6 to 8 feet below mudline		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline
PDI-079	--	--	Consecutive 2-foot intervals throughout core penetration depth	--	--	--	--		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline
PDI-080	--	--	Consecutive 2-foot intervals throughout core penetration depth	--	--	--	--		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline
PDI-081	--	0- to 2-foot, 2- to 5-foot, 5- to 7-foot, 7- to 10-foot, and 10- to 13-foot intervals	--	--	--	--	--		0 to 2 feet, 2 to 5 feet, and 5 to 7 feet below mudline	--
PDI-082	--	0- to 2-foot, 2- to 5-foot, 5- to 7-foot, 7- to 10-foot, and 10- to 13-foot intervals	--	--	--	--	--		0 to 2 feet, 2 to 5 feet, and 5 to 7 feet below mudline	--
PDI-083	--	--	Consecutive 2-foot intervals throughout core penetration depth	--	--	--	--		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline
PDI-084	--	0- to 2-foot, 2- to 5-foot, 5- to 7-foot, 7- to 10-foot, and 10- to 13-foot intervals	--	--	--	--	--		0 to 2 feet, 2 to 5 feet, and 5 to 7 feet below mudline	--
PDI-085	--	--	Consecutive 2-foot intervals throughout core penetration depth	Vertical composite from mudline to DOC	Vertical composite from mudline to DOC	--	--		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline

Table A-4
Subsurface Sediment Sampling Intervals

Sediment Core Location	Sampling Program									
		Cap Modelling							Additional Analysis	
	DOC[1]	Dredge and Cap or Capping Only Nearshore[2]	Dredge and Cap or Capping Only Offshore[3]	Waste Characterization[4]	Barge Dewatering (Dredge Elutriate)[4]	Porewater[5]	Biogas Generation Potential	NAPL Mobility	Nearshore	Offshore
PDI-086	--	0- to 2-foot, 2- to 5-foot, 5- to 7-foot, 7- to 10-foot, and 10- to 13-foot intervals	--	--	--	--	--	To be determined based on field observations of PTW-NAPL presence	0 to 2 feet, 2 to 5 feet, and 5 to 7 feet below mudline	--
PDI-087	--	--	Consecutive 2-foot intervals throughout core penetration depth	--	--	--	--		--	0 to 2 feet, 2 to 4 feet, 4 to 6 feet, and 6 to 8 feet below mudline
PDI-088	--	--	--	--	--	--	--		--	1 to 2 feet, 2 to 3 feet, and 3 to 4 feet below mudline

Table A-4
Subsurface Sediment Sampling Intervals

Notes:
1. Sampling intervals for DOC cores start at two successive intervals from the bottom depth of recovery toward the mudline. Remaining intervals will be archived in 1-foot intervals.
2. Sampling intervals for nearshore dredge and cap or capping-only cores are 0 to 2 feet, 2 to 5 feet, 5 to 7 feet, 7 to 10 feet, and 10 to 13 feet below mudline. Potentially deeper samples will be collected if PTW-NAPL is identified.
3. Sampling intervals for offshore dredge and cap or capping only cores outside the navigation channel are consecutive 2-foot intervals throughout core penetration. Sampling intervals for offshore dredge and cap cores inside the navigational channel are consecutive 2-foot intervals throughout the penetration depth starting at -47 feet COP elevation.
4. Waste characterization and barge dewatering samples will be collected from one vertically composited sample from existing mudline to the DOC, which will be estimated based on visual and olfactory indications of contamination.
5. Porewater samples will be collected from 4 to 6 feet below mudline unless PTW-NAPL is observed in that interval. If PTW-NAPL is observed, a new interval will be determined in the field.

COP: City of Portland datum
DOC: depth of contamination
NAPL: nonaqueous phase liquid
PTW: principal threat waste
TBD: to be determined

Table A-5
Geotechnical Core and In Situ Penetration Test Locations and Depths

Station Location	Target Coordinates[1]		Sampling Method	Target Penetration (feet)	Sample Intervals	Number of Cores per Station	Subsurface Sediment and Native Material Testing[2,3]	Archive
	Easting (X)	Northing (Y)						
Geotechnical Coring								
PDI-094	7623201.14	706140.80	Sonic core barrel	Estimated at 5 to 10 feet of penetration below the bottom of proposed sheetpile depth (if consistent medium dense or very stiff conditions encountered), 65 feet below mudline, or to equipment/sampling refusal, whichever occurs first. Penetration depths will vary.	Varies based on sediment thickness and lithology; one to five intervals per core	1 to 2	Moisture content, Atterberg Limits, grain size, specific gravity, dry bulk density, one-dimensional consolidation, direct shear strength, and triaxial shear strength	Archive remaining intervals
PDI-095	7623421.47	706079.85						
PDI-096	7623516.04	705902.01						
PDI-097	7623716.76	706095.22						
PDI-098	7623811.41	705892.82						
PDI-099	7623903.08	705773.17						
PDI-100	7623974.01	705588.63						
PDI-101	7624223.06	705492.23						
PDI-102	7624283.66	705632.15						
PDI-103	7624422.86	705501.46						
PDI-104	7624540.51	705576.07						
PDI-105	7624673.71	705241.41						
PDI-106	7624768.47	705304.03						
PDI-107	7625067.33	705117.23						
PDI-108	7625034.17	705039.98						
PDI-109	7625194.92	705013.83						
PDI-110	7625357.86	704879.48						
In Situ Penetration Tests								
PDI-111	7623357.59	705978.41	CPT/FFP	Estimated at 5 to 10 feet of penetration below the bottom of proposed sheetpile depth (if consistent medium dense or very stiff conditions encountered), 65 feet below mudline, or to equipment/sampling refusal, whichever occurs first. Penetration depths will vary.	Data continuously collected during test as the probe is pushed into sediment and native material; no samples collected	1	In situ measurements of resistance, friction, and porewater pressure	N/A
PDI-112	7623677.16	705907.26						
PDI-113	7624130.84	705611.50						
PDI-114	7624360.13	705448.95						
PDI-115	7624467.21	705346.65						
PDI-116	7624584.84	705445.01						
PDI-117	7624847.95	705149.93						
PDI-118	7624969.33	705219.40						
PDI-119	7625216.42	704930.96						

Notes:
1. Coordinates are in North American Datum of 1983 (HARN91) Oregon State Plane North, International Feet.
2. All ASTM International test standards will be the most current adopted version, as of the time of sampling.
3. Bulk density includes both wet and dry results.
CPT: cone penetration test
FFP: full-flow penetration
N/A: not applicable

Table A-6
Sample Handling and Storage

Parameter	Sample Size	Container Size and Type[1]	Holding Time	Sample Preservation Technique	Laboratory
Moisture content	100 g	1 to 4 gallons in zip-top bags	None	None	NWG
Specific gravity	100 g		None	None	
Atterberg limits	100 g		None	None	
Grain size	100 g		None	None	
Bulk density	300 g	Shelby tubes	None	None	
Unconsolidated undrained (UU) triaxial	100 g		None	None	
Consolidated undrained (CU) triaxial	100 g		None	None	
Consolidated drained triaxial	100 g		None	None	
1-D consolidation	100 g		None	None	
Direct shear	100 g		None	None	
SICT	100 g	16-oz glass or HDPE	None	None	University of Colorado
Total solids	50 g	16-oz glass	None	Cool <6°C	All
Total organic carbon	50 g		28 days	Cool <6°C	Apex
			6 months	Freeze -18°C	
Cyanide	50 g		14 days	Cool 2 to 6°C	
Metals	5 g		180 days	Cool <6°C	
BOD	10 g	4-oz glass	48 hours	Cool <6°C	
COD	10 g		28 days	Cool <6°C	
VOCs	5 g	40-mL VOA vial with PTFE-lined septum caps (3x)	14 days	Cool 2 to 6°C/$NaHSO_4$ (two vials)/ MeOH (one vial)	
SVOCs, PAHs, PCB Aroclors, pesticides, herbicides, DRO	200 g	16-oz glass	14 days until extraction	Cool <6°C	
			1 year until extraction	Freeze -18°C	
			40 days after extraction	Cool <6°C	
TCLP metals	100 g	8-oz glass	180 days to TCLP extraction	Cool <6°C	
			180 days to analysis	HNO_3 to pH <2	
TCLP SVOCs, pesticides, herbicides	300 g	2 x 16-oz glass	14 days to TCLP extraction	Cool <2 to 6°C	
			7 days to extraction		
			40 days after extraction		
TCLP VOCs	100 g	4-oz glass, no headspace	14 days to TCLP extraction	Cool <6°C	
			14 days to analysis	HCl to pH <2	
DRET pH	10 g dry sediment to 1 L site water	5-gallon bucket	14 days to DRET extraction	Ambient	WST/Apex
			Analyze immediately	Cool <2 to 6°C	
DRET TSS			7 days to DRET extraction	Ambient	
			7 days to analysis	Cool <2 to 6°C	
DRET VOCs			14 days to DRET extraction	Ambient	
			14 days to analysis	HCl to pH <2	
DRET SVOCs, pesticides, herbicides, PCBs, TBTs			14 days to DRET extraction	Ambient	
			7 days to extraction	Cool <2 to 6°C	
			40 days after extraction		
DRET metals			180 days to DRET extraction	Ambient	
			180 days to analysis	HNO_3 to pH <2	
DRET dioxin/furans			1 year to DRET extraction	Ambient	
			1 year to analysis	Cool <2 to 6°C	
PCB congeners	30 g	4-oz glass	None	Cool <6°C/freeze -18°C	Vista
Dioxin/furans and HR pesticides			1 year to extraction	Freeze -18°C	
			1 year after extraction		
EPH	150 g	4-oz glass	14 days until extraction	Cool <6°C	
			1 year until extraction	Freeze -18°C	ARI
			40 days after extraction	Cool <6°C	
Perchlorate	50 g	8-oz glass	28 days to extraction, 28 days after extraction	Cool <6°C	Alpha
Soot carbon	50 g		28 days	Cool <6°C	
			6 months	Freeze -18°C	
pH, ignitability	25 g	8-oz glass	14 days	Cool 2 to 6°C	
Core slabbing and preparation	--	Undisturbed core sections	None	Cool <6°C	Core Labs
Core photography with white light and UV	--	Undisturbed core sections	None	Cool <6°C	
Grain density	--	Undisturbed core sections	None	Cool <6°C	
Porosity	--	Undisturbed core sections	None	Cool <6°C	
Vertical permeability	--	Undisturbed core sections	None	Cool <6°C	
Capillary pressure	--	Undisturbed core sections	None	Cool <6°C	
Free product mobility via centrifuge	--	Undisturbed core sections	None	Cool <6°C	
Pore fluid saturations (NAPL and water)	--	Undisturbed core sections	None	Cool <6°C	

Table A-6
Sample Handling and Storage

Parameter	Sample Size	Container Size and Type[1]	Holding Time	Sample Preservation Technique	Laboratory
Dry bulk density	--	--	--	--	PTS
Hydraulic conductivity	--	--	--	--	
Fluid density, specific gravity	50 mL[2]	2 x 40-mL VOA vial	None	Ambient	
NAPL viscosity			None	Ambient	
NAPL interfacial tension			None	Ambient	
Wettability (droplet method)			None	Ambient	
Water					
TSS	1 L	1-L HDPE	4 days	Cool 2 to 6°C	Apex
Total organic carbon	10 mL	2 x 40-mL VOA vial	28 days	2 to 6°C; H_2SO_4 to pH <2	
Dissolved organic carbon	10 mL	2 x 40-mL VOA vial	28 days	2 to 6°C; H_2SO_4 to pH <2	
Cyanide	100 mL	1 x 125-mL brown HDPE with NaOH and 125-mL unpreserved	14 days	Cool 2 to 6°C; NaOH to pH >12	
Metals	100 mL	500-mL HDPE	180 days	Cool 2 to 6°C; HNO_3 to pH <2	
pH	10 mL	250-mL HDPE	ASAP	Cool 2 to 6°C	
VOCs	5 mL	40-mL VOA vial with PTFE-lined septum caps (3x)	14 days	Cool 4 to 6°C/HCl to pH <2	
SVOCs	1 L	2 x 1-L amber glass	7 days until extraction	Cool 2 to 6°C	
			40 days after extraction		
PAHs	1 L	2 x 1-L amber glass	7 days until extraction	Cool 2 to 6°C	
			40 days after extraction		
Pesticides	1 L	2 x 1-L amber glass	7 days until extraction	Cool 2 to 6°C	
			40 days after extraction		
Herbicides	1 L	2 x 1-L amber glass	7 days until extraction	Cool 2 to 6°C	
			40 days after extraction		
Butyltins	1 L	2 x 1-L amber glass	7 days until extraction	Cool 2 to 6°C	
			40 days after extraction		
PCB congeners	1 L	2 x 1-L amber glass	7 days until extraction	Cool 2 to 6°C	
			40 days after extraction		
Dioxin/furans	1 L	2 x 1-L amber glass	1 year until extraction	Cool 2 to 6°C	
			1 year after extraction		
EPH	1 L	2 x 1-L amber glass	14 days until extraction	Cool 2 to 6°C	
			40 days after extraction		
Perchlorate	100 mL	250-mL HDPE; filter with syringe filter	28 days	Cool 2 to 6 °C	
Sheen Nets					
Total petroleum hydrocarbons	1 net	8-oz glass	No established hold time to extraction	Cool 2 to 6°C	Alpha
			40 days after extraction		

Notes:
1. Container size, type, and sample size required may change based on laboratory guidance.
2. More or less may be sent for analysis, depending on volume available.
--: not applicable
ARI: Analytical Resources, Inc.
ASAP: as soon as possible
BOD: biochemical oxygen demand
COD: chemical oxygen demand
DRET: Dredged Elutriate Testing
DRO: diesel range organic
EPH: extractable petroleum hydrocarbon
g: gram
H_2SO_4: sulfuric acid
HCl: hydrochloric acid
HDPE: high-density polyethylene
HNO_3: nitric acid
HR: high resolution
L: liter
MeOH: methanol
mL: milliliter
$NaHSO_4$: sodium bisulfate
NaOH: sodium hydroxide
NAPL: nonaqueous phase liquid
NWG: Northwest Geotech
oz: ounce
PAH: polycyclic aromatic hydrocarbon
PCB: polychlorinated biphenyl
PTFE: polytetrafluoroethylene (Teflon)
SICT: seepage induced consolidation test
SVOC: semivolatile organic compound
TBT: tributyltin
TCLP: toxicity characteristic leaching procedure
TSS: total suspended solids
UV: ultraviolet
VOA: volatile organic analysis
VOC: volatile organic compound
WST: Waste Stream Technology

Table A-7
Chemical and Physical Analytes by Sampling Task

Chemical and Physical Analyses		Surface Sediments			Subsurface Sediments								
Analyte Group	**Analytes**	**Surface Grabs**	**Depositional Surface Grabs**	**River Bank Boring Soil**	**DOC**	**Cap Model Testing**	**Waste Charater-ization**	**Barge Dewatering**	**NAPL Mobility Testing**	**Biogas Generation Potential**	**Extracted NAPL**	**Additional Analyses – Cap Model Testing**	**Analyses – DOC and Extracted NAPL**
Geotechnical	Analytes vary by sampling task—see QAPP for complete analyte lists			X	X	X			X	X			
Conventionals	TS and TOC	X	X	X	X	X			X				
Conventionals	List deviates from TS and TOC—see QAPP for complete analyte lists						X	X		X			
Metals	Analytes vary by sampling task—see QAPP for complete analyte lists		X	X		X	X	X					
VOCs (µg/kg)	Analytes vary by sampling task—see QAPP for complete analyte lists			X		X	X	X					
PAHs	Sixteen EPA priority pollutant PAHs and 2-methylnaphthalene	X	X	X	X	X							
PAHs and Alkylated PAHs	See QAPP for analyte list								X				X
SVOCs	Analytes vary by sampling task—see QAPP for complete analyte lists		X	X		X	X						
PCB	PCB-001 209	X	X										
PCB Aroclors	Aroclors 1016, 1221, 1232, 1242, 1248, 1254, 1260, 1262, and 1268			X	X			X				X	
Dioxin/furans	Seventeen 2,3,7,8-substituted congeners	X	X	X	X			X				X	
Low-resolution pesticides	Six DDx congeners	X			X		X	X				X	
High-resolution pesticides	Six DDx congeners; aldrin, cis-chlordane, trans-chlordane, oxychlordane, cis-nonachlor, trans-nonachlor, dieldrin, lindane		X	X									
TPH	Diesel range organics		X	X									
TPH	TPH(C9-C44)									X	X		X
Saturated hydrocarbons	N/A									X			X
Petroleum biomarkers	N/A												X
Organometallics (µg/kg)	Tributyltin		X	X				X					
Herbicides	2,4-D, 2,4,5-TP (silvex)						X						
Herbicides	MCPP							X					
TCLP Metals	See QAPP for analyte list						X						
TCLP VOCs	See QAPP for analyte list						X						
TCLP SVOCs	See QAPP for analyte list						X						
TCLP Pesticides	See QAPP for analyte list						X						
TCLP Herbicides	See QAPP for analyte list						X						
NAPL Mobility Testing	See QAPP for analyte list								X				

Notes:
µg/kg: micrograms per kilogram
DDx: 2,4′ and 4,4′-DDD, -DDE, -DDT
DOC: depth of contamination
EPA: U.S. Environmental Protection Agency
MCPP: methylchlorophenoxypropionic acid
N/A: not applicable
NAPL: nonaqueous phase liquid
PAH: polycyclic aromatic hydrocarbon
PCB: polychlorinated biphenyl
QAPP: Quality Assurance Project Plan
SVOC: semivolatile organic compound
TCLP: toxicity characteristic leaching procedure
TOC: total organic carbon
TPH: total petroleum hydrocarbons
TS: total solid
VOC: volatile organic compound

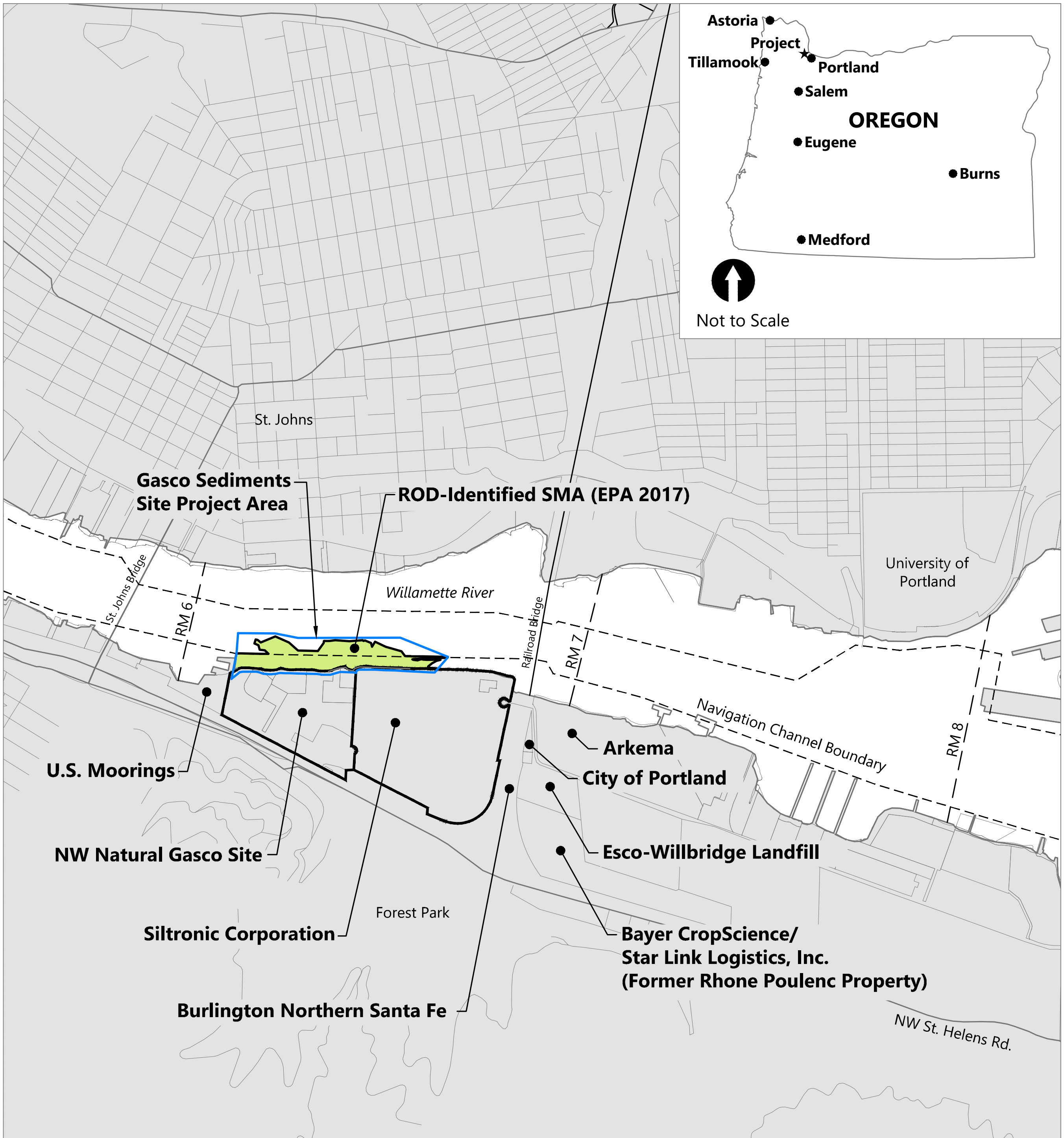
Table A-7
Chemical and Physical Analytes by Sampling Task

Chemical and Physical Analyses		Paired Sampling			
Analyte Group	Analytes	Subsurface Sediment	Porewater	Ebullition Sheen	Geotechnical
Geotechnical	Analytes vary by sampling task—see QAPP for complete analyte lists				X
Conventionals	TS and TOC	X			
Conventionals	List deviates from TS and TOC—see QAPP for complete analyte lists				
Metals	Analytes vary by sampling task—see QAPP for complete analyte lists				
VOCs (µg/kg)	Analytes vary by sampling task—see QAPP for complete analyte lists	X	X		
PAHs	Sixteen EPA priority pollutant PAHs and 2-methylnaphthalene	X	X		
PAHs and Alkylated PAHs	See QAPP for analyte list				
SVOCs	Analytes vary by sampling task—see QAPP for complete analyte lists				
PCB	PCB-001 209				
PCB Aroclors	Aroclors 1016, 1221, 1232, 1242, 1248, 1254, 1260, 1262, and 1268				
Dioxin/furans	Seventeen 2,3,7,8-substituted congeners				
Low-resolution pesticides	Six DDx congeners				
High-resolution pesticides	Six DDx congeners; aldrin, cis-chlordane, trans-chlordane, oxychlordane, cis-nonachlor, trans-nonachlor, dieldrin, lindane				
TPH	Diesel range organics			X	
TPH	TPH(C9-C44)			X	
Saturated hydrocarbons	N/A				
Petroleum biomarkers	N/A				
Organometallics (µg/kg)	Tributyltin				
Herbicides	2,4-D, 2,4,5-TP (silvex)				
Herbicides	MCPP				
TCLP Metals	See QAPP for analyte list				
TCLP VOCs	See QAPP for analyte list				
TCLP SVOCs	See QAPP for analyte list				
TCLP Pesticides	See QAPP for analyte list				
TCLP Herbicides	See QAPP for analyte list				
NAPL Mobility Testing	See QAPP for analyte list				

Notes:
µg/kg: micrograms per kilogram
DDx: 2,4' and 4,4'-DDD, -DDE, -DDT
DOC: depth of contamination
EPA: U.S. Environmental Protection Agency
MCPP: methylchlorophenoxypropionic acid
N/A: not applicable
NAPL: nonaqueous phase liquid
PAH: polycyclic aromatic hydrocarbon
PCB: polychlorinated biphenyl
QAPP: Quality Assurance Project Plan
SVOC: semivolatile organic compound
TCLP: toxicity characteristic leaching procedure
TOC: total organic carbon
TPH: total petroleum hydrocarbons
TS: total solid
VOC: volatile organic compound

Attachment C

DGWP Appendix A Updated Figures



HORIZONTAL DATUM: Oregon State Plane North, North American Datum (NAD83/HARN 91), International Feet.

NOTE: All locations are approximate.

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Filepath: K:\Projects\0029-NW Natural Gas Co\Gasco Sediments_Pre-Remedial Design\Pre_RD Data Gaps Field Sampling Plan\0029-RP-001 (Vicinity Map).dwg Figure A-1

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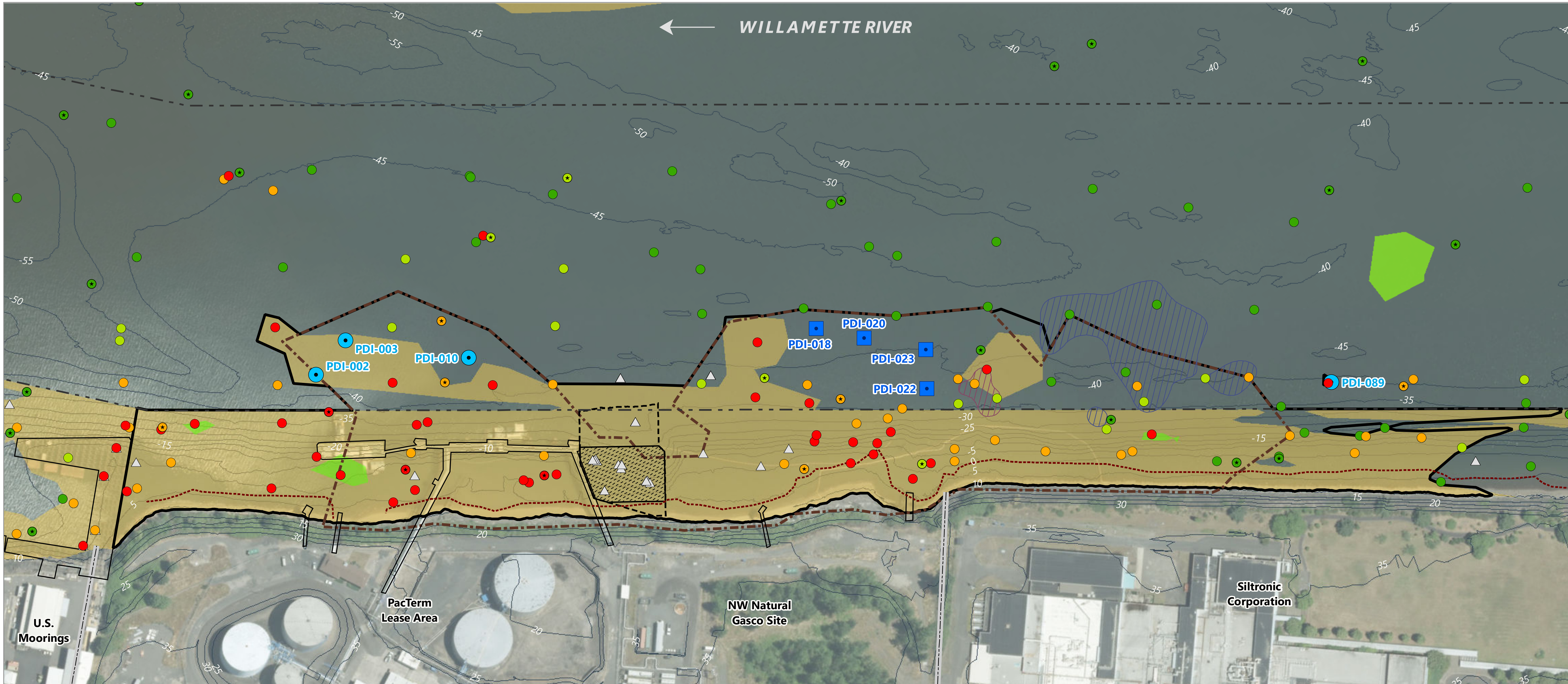
Figure A-1
Vicinity Map

Pre-Remedial Design Data Gaps Field Sampling Plan
Gasco Sediments Cleanup Action



LEGEND:

- Navigation Channel
- Structures
- Property Line
- Tar Body Removal Action Area (RAPP, Anchor 2005)
- Tar Body Removal Action Pilot Cap
- PTW-NAPL Boundary
- Elevation (feet COP)
- Approximate Riprap Boundary[1]
- ROD-Identified SMAs (EPA 2017) Included in the Ga sco Sedim ent Site Interim Project Area[2]
- Total Area Exceeding ROD Table 21 Focused COC RALs and PTW-Highly Toxic Additional Contaminant Thresholds[3]
- Total PCB PTW-Highly Toxic Additional Contaminant Threshold Exceedance
- 2010 Transition Zone Water Vinyl Chloride Area 1 Boundary (Anchor QEA 2012)[4]
- Area 2 – Detected CVOCs in TZW and One Subsurface Sediment Location[5]

Total PAH (µg/kg)

- ≤ ROD RAL (13,000)
- > ROD RAL (13,000) and ≤ ROD RAL ESD (30,000)
- > ROD RAL ESD (30,000) and ≤ Nav ROD RAL (170,000)
- > Nav ROD RAL (170,000)

- Pre-RD Group Harborwide Monitoring Surface Sample Location (AECOM and Geosyntec 2018a)
- Surface Sample Locations Not Included in the ROD
- Surface Sample Location Included in the ROD
- Proposed Interim Project Area Verification Surface Sediment Grab
- Proposed 0- to 1-Foot Interval For Additional Surface Sediment Concentration Data Density

NOTES:

1. Estimated from side scan sonar survey conducted by Blue Water Engineering April 2011.
2. All depicted SMA technology and PTW contours taken from the Portland Harbor Superfund Site Record of Decision (2017) without application of the EPA Explanation of Significant Differences (ESD; EPA 2018), which is not yet finalized.
3. Total area determined based on exceedances of ROD Table 21 focused COC RALs and PTW-highly toxic additional contaminant thresholds. Does not account for ESD, which is still undergoing public review and comment.
4. Boundary taken from Draft Engineering Evaluation/Cost Analysis, Appendix A, Figure 4.2. Transition zone water screening level exceedances of cis-1,2-dichloroethene identified within this vinyl chloride boundary.
5. Boundary taken from Gasco Sediments Site Statement of Work, Figure 1 (EPA 2009).
6. Bathymetry surveyed by DEA 2018. Topography surveyed by Geometrix 2011.
7. Arrow indicates direction of flow of river.
8. Horizontal datum is NAD83 (HARN 91) Oregon State Plane North, International Feet.
9. Vertical datum is City of Portland (COP), Feet.
10. Aerial imagery from City of Portland 2016.

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Figure A-2
Proposed Interim Project Area Surface Sediment Grabs
Pre-Remedial Design Data Gaps Field Sampling Plan
Gasco Sediments Cleanup Action

LEGEND:

- Navigation Channel
- Structures
- Property Line
- Tar Body Removal Action Area (RAPP, Anchor 2005)
- Tar Body Removal Action Pilot Cap
- PTW-NAPL Boundary
- Elevation (feet COP)
- Approximate Riprap Boundary[1]

ROD SMA Technology[2]

- Cap
- Dredge
- Dredge in Nav-FMD
- Dredge with Cap
- 2010 Transition Zone Water Vinyl Chloride Area 1 Boundary (Anchor QEA 2012)[3]
- Area 2 – Detected CVOCs in TZW and One Subsurface Sediment Location[4]

- Extent of DNAPL Deemed Potentially Mobile Identified in Interim Feasibility Study (Anchor QEA 2018b; 0 to 12 feet)
- Extent of DNAPL Deemed Potentially Mobile Identified in Interim Feasibility Study (Anchor QEA 2018b; 12 to 22 feet)
- Existing Cores with Previously Observed PTW-NAPL
- Existing Subsurface Sample Location
- Proposed Angled Top of Riverbank Boring[5]

NOTES:

1. Estimated from side scan sonar survey conducted by Blue Water Engineering April 2011.
2. All depicted SMA technology and PTW contours taken from the Portland Harbor Superfund Site Record of Decision (2017) without application of the EPA Explanation of Significant Differences (ESD; EPA 2018), which is not yet finalized.
3. Boundary taken from Draft Engineering Evaluation/Cost Analysis, Appendix A, Figure 4.2. Transition zone water screening level exceedances of cis-1,2-dichloroethene identified within this vinyl chloride boundary.
4. Boundary taken from Gasco Sediments Site Statement of Work, Figure 1 (EPA 2009).
5. The locations may need to be adjusted in the field as necessary to facilitate equipment access.
6. Bathymetry surveyed by DEA 2018. Topography surveyed by Geometrix 2011.
7. Arrow indicates direction of flow of river.
8. Horizontal datum is NAD83 (HARN 91) Oregon State Plane North, International Feet.
9. Vertical datum is City of Portland (COP), Feet.
10. Aerial imagery from City of Portland 2016.

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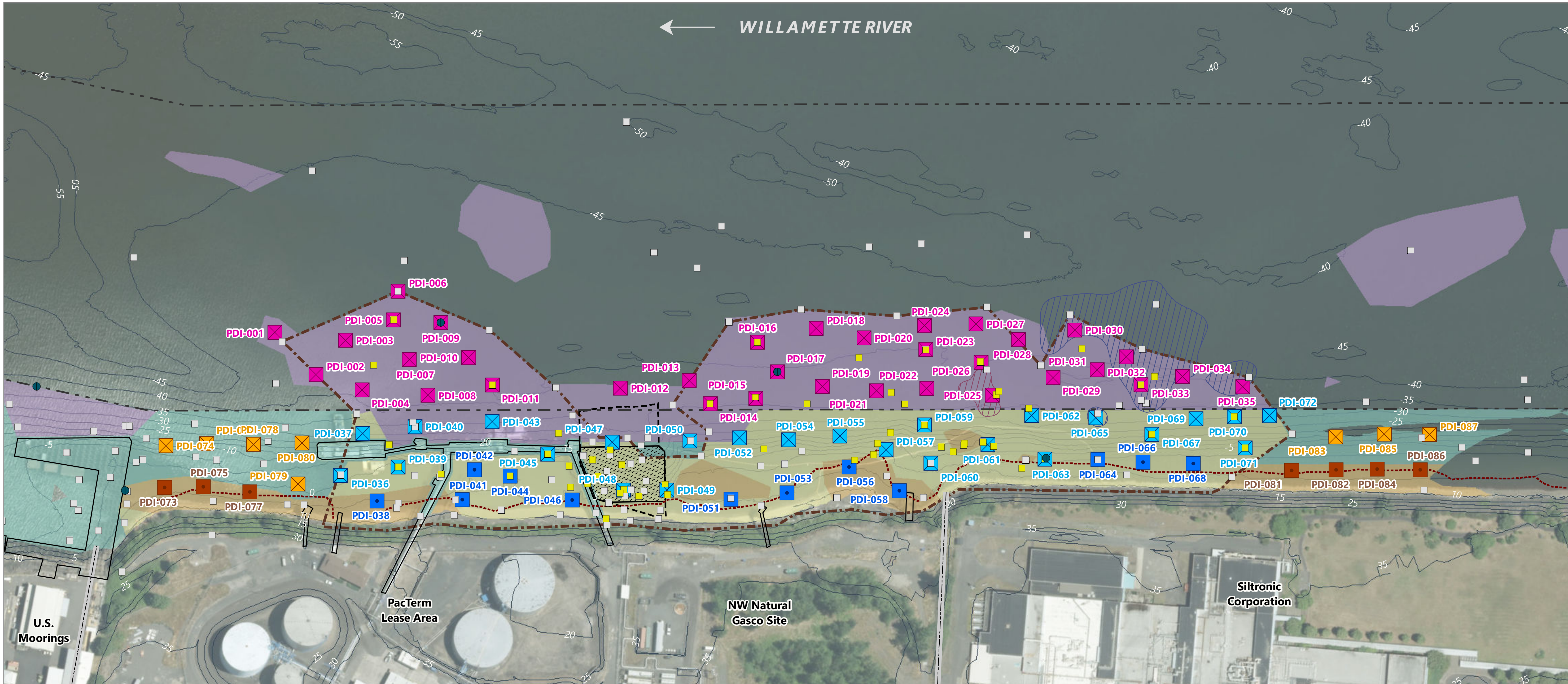
Figure A-3
Proposed Angled Top of Riverbank Borings
Pre-Remedial Design Data Gaps Field Sampling Plan
Gasco Sediments Cleanup Action



LEGEND:

- Navigation Channel
- Structures
- Property Line
- Tar Body Removal Action Area (RAPP, Anchor 2005)
- Tar Body Removal Action Pilot Cap
- PTW-NAPL Boundary
- Elevation (feet COP)
- Approximate Riprap Boundary [1]

ROD SMA Technology[2]

- Cap
- Dredge
- Dredge in Nav-FMD
- Dredge with Cap
- 2010 Transition Zone Water Vinyl Chloride Area 1 Boundary (Anchor QEA 2012)[3]
- Area 2 – Detected CVOCs in TZW and One Subsurface Sediment Location[4]

- Pre-RD Group Harborwide Monitoring Subsurface Sample Location (AECOM and Geosyntec 2018a)
- Existing Cores with Previously Observed PTW-NAPL
- Existing Subsurface Sample Location

Proposed Capping Only Cores

- Consecutive 2-ft Intervals Throughout Core Penetration Depth
- 0-2 ft, 2-5 ft, 5-7 ft, 7-10 ft, and 10-13 ft Intervals[5,6]

Proposed Dredge and Cap Cores[7]

- Consecutive 2-ft Intervals Throughout Core Penetration Depth
- 0-2 ft, 2-5 ft, 5-7 ft, 7-10 ft, and 10-13 ft Intervals[5,6]
- Consecutive 2-ft Intervals Throughout Core Penetration Depth Initiating at -47 Feet COP Elevation[8]

NOTES:

1. Estimated from from side scan sonar survey conducted by Blue Water Engineering April 2011.
2. All depicted SMA technology and PTW contours taken from the Portland Harbor Superfund Site Record of Decision (2017) without application of the EPA Explanation of Significant Differences (ESD; EPA 2018), which is not yet finalized.
3. Boundary taken from Draft Engineering Evaluation/Cost Analysis, Appendix A, Figure 4.2. Transition zone water screening level exceedances of cis-1,2-dichloroethene identified within this vinyl chloride boundary.
4. Boundary taken from Gasco Sediments Site Statement of Work, Figure 1 (EPA 2009).
5. Potentially deeper samples will be collected if PTW-NAPL is identified. NAPL mobility testing may be conducted based on PTW-NAPL observations in deeper intervals.
6. The nearshore core locations may need to be adjusted further offshore depending on the river elevations during sample collection to facilitate vessel access.
7. All dredge and cap core locations are identical to DOC locations shown in Figure 5.
8. Capping in the channel becomes feasible in the navigation channel below -47 feet COP, based on ROD-identified -43 feet Columbia River Datum (CRD) authorized federal maintenance dredging elevation plus 3 feet overdredge plus 4- to 5-foot underlying cap thickness plus conversion from CRD to COP datum.
9. Bathymetry surveyed by DEA 2018. Topography surveyed by Geometrix 2011.
10. Arrow indicates direction of flow of river.
11. Horizontal datum is NAD83 (HARN 91) Oregon State Plane North, International Feet.
12. Vertical datum is City of Portland (COP), Feet.
13. Aerial imagery from City of Portland 2016.

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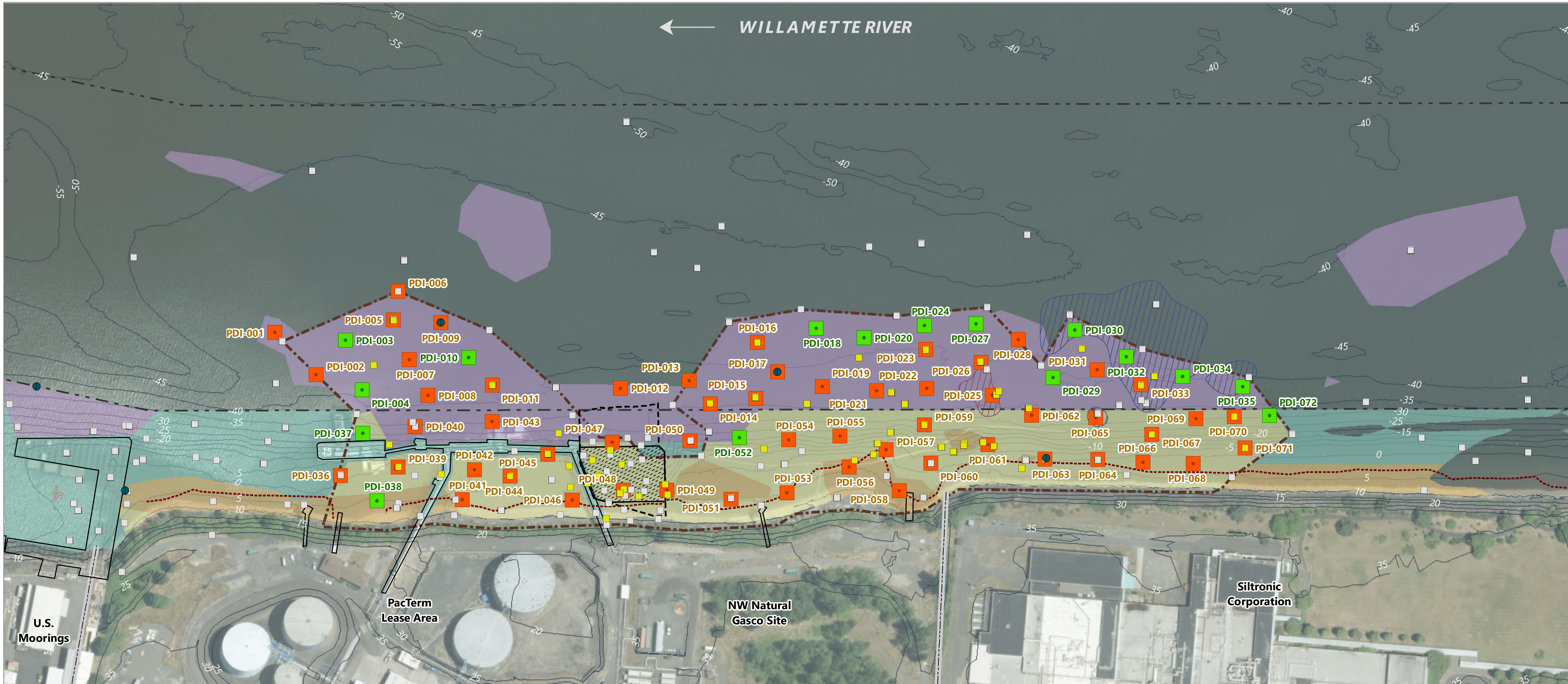
Figure A-4
Proposed Subsurface Capping Demonstration Cores
Pre-Remedial Design Data Gaps Field Sampling Plan
Gasco Sediments Cleanup Action



LEGEND:

- Navigation Channel
- Structures
- Property Line
- Tar Body Removal Action Area (RAPP, Anchor 2005)
- Tar Body Removal Action Pilot Cap
- PTW-NAPL Boundary
- Elevation (feet COP)
- Approximate Riprap Boundary [1]

ROD SMA Technology[2]

- Cap
- Dredge
- Dredge in Nav-FMD
- Dredge with Cap
- 2010 Transition Zone Water Vinyl Chloride Area 1 Boundary (Anchor QEA 2012)[3]
- Area 2 – Detected CVOCs in TZW and One Subsurface Sediment Location[4]

- Pre-RD Group Harborwide Monitoring Subsurface Sample Location (AECOM and Geosyntec 2018a)
- Existing Cores with Previously Observed PTW-NAPL
- Existing Subsurface Sample Location
- Proposed DOC Core[5]
- Proposed DOC and PTW-NAPL Refinement Core

NOTES:

1. Estimated from side scan sonar survey conducted by Blue Water Engineering April 2011.
2. All depicted SMA technology and PTW contours taken from the Portland Harbor Superfund Site Record of Decision (2017) without application of the EPA Explanation of Significant Differences (ESD; EPA 2018), which is not yet finalized.
3. Boundary taken from Draft Engineering Evaluation/Cost Analysis, Appendix A, Figure 4.2. Transition zone water screening level exceedances of cis-1,2-dichloroethene identified within this vinyl chloride boundary.
4. Boundary taken from Gasco Sediments Site Statement of Work, Figure 1 (EPA 2009).
5. The nearshore core locations may need to be adjusted further offshore depending on the river elevations during sample collection to facilitate vessel access.
6. Bathymetry surveyed by DEA 2018. Topography surveyed by Geometrix 2011.
7. Arrow indicates direction of flow of river.
8. Horizontal datum is NAD83 (HARN 91) Oregon State Plane North, International Feet.
9. Vertical datum is City of Portland (COP), Feet.
10. Aerial imagery from City of Portland 2016.

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Figure A-5
Proposed Subsurface Depth of Contamination and PTW-NAPL Boundary Refinement Cores
Pre-Remedial Design Data Gaps Field Sampling Plan
Gasco Sediments Cleanup Action

LEGEND:

- Navigation Channel
- Structures
- Property Line
- Tar Body Removal Action Area (RAPP, Anchor 2005)
- Tar Body Removal Action Pilot Cap
- PTW-NAPL Boundary
- Elevation (feet COP)
- Approximate Riprap Boundary [1]

ROD SMA Technology [2]

- Cap
- Dredge
- Dredge in Nav-FMD
- Dredge with Cap
- 2010 Transition Zone Water Vinyl Chloride Area 1 Boundary (Anchor QEA 2012) [3]
- Area 2 – Detected CVOCs in TZW and One Subsurface Sediment Location [4]

- Pre-RD Group Harborwide Monitoring Subsurface Sample Location (AECOM and Geosyntec 2018a)
- Existing Cores with Previously Observed PTW-NAPL
- Existing Subsurface Sample Location
- Barge Dewatering Treatment and Stabilization Evaluation Core

NOTES:

1. Estimated from side scan sonar survey conducted by Blue Water Engineering April 2011.
2. All depicted SMA technology and PTW contours taken from the Portland Harbor Superfund Site Record of Decision (2017) without application of the EPA Explanation of Significant Differences (ESD; EPA 2018), which is not yet finalized.
3. Boundary taken from Draft Engineering Evaluation/Cost Analysis, Appendix A, Figure 4.2. Transition zone water screening level exceedances of cis-1,2-dichloroethene identified within this vinyl chloride boundary.
4. Boundary taken from Gasco Sediments Site Statement of Work, Figure 1 (EPA 2009).
5. Bathymetry surveyed by DEA 2018. Topography surveyed by Geometrix 2011.
6. Arrow indicates direction of flow of river.
7. Horizontal datum is NAD83 (HARN 91) Oregon State Plane North, International Feet.
8. Vertical datum is City of Portland (COP), Feet.
9. Aerial imagery from City of Portland 2016.

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Figure A-6
Proposed Dredge Material Barge Dewatering Treatment and Stabilization Evaluation Cores
Pre-Remedial Design Data Gaps Field Sampling Plan
Gasco Sediments Cleanup Action

LEGEND:

- Navigation Channel
- Structures
- Property Line
- Tar Body Removal Action Area (RAPP, Anchor 2005)
- Tar Body Removal Action Pilot Cap
- PTW-NAPL Boundary
- Elevation (feet COP)
- Approximate Riprap Boundary [1]

ROD SMA Technology[2]

- Cap
- Dredge
- Dredge in Nav-FMD
- Dredge with Cap
- 2010 Transition Zone Water Vinyl Chloride Area 1 Boundary (Anchor QEA 2012)[3]
- Area 2 – Detected CVOCs in TZW and One Subsurface Sediment Location[4]

- Pre-RD Group Harborwide Monitoring Subsurface Sample Location (AECOM and Geosyntec 2018a)
- Existing Cores with Previously Observed PTW-NAPL
- Existing Subsurface Sample Location
- Existing TCLP Location
- Proposed TCLP/RBC Location

NOTES:

1. Estimated from side scan sonar survey conducted by Blue Water Engineering April 2011.
2. All depicted SMA technology and PTW contours taken from the Portland Harbor Superfund Site Record of Decision (2017) without application of the EPA Explanation of Significant Differences (ESD; EPA 2018), which is not yet finalized.
3. Boundary taken from Draft Engineering Evaluation/Cost Analysis, Appendix A, Figure 4.2. Transition zone water screening level exceedances of cis-1,2-dichloroethene identified within this vinyl chloride boundary.
4. Boundary taken from Gasco Sediments Site Statement of Work, Figure 1 (EPA 2009).
5. Bathymetry surveyed by DEA 2018. Topography surveyed by Geometrix 2011.
6. Arrow indicates direction of flow of river.
7. Horizontal datum is NAD83 (HARN 91) Oregon State Plane North, International Feet.
8. Vertical datum is City of Portland (COP), Feet.
9. Aerial imagery from City of Portland 2016.

TCLP: toxicity characteristic leaching procedure
RBC: risk-based concentration

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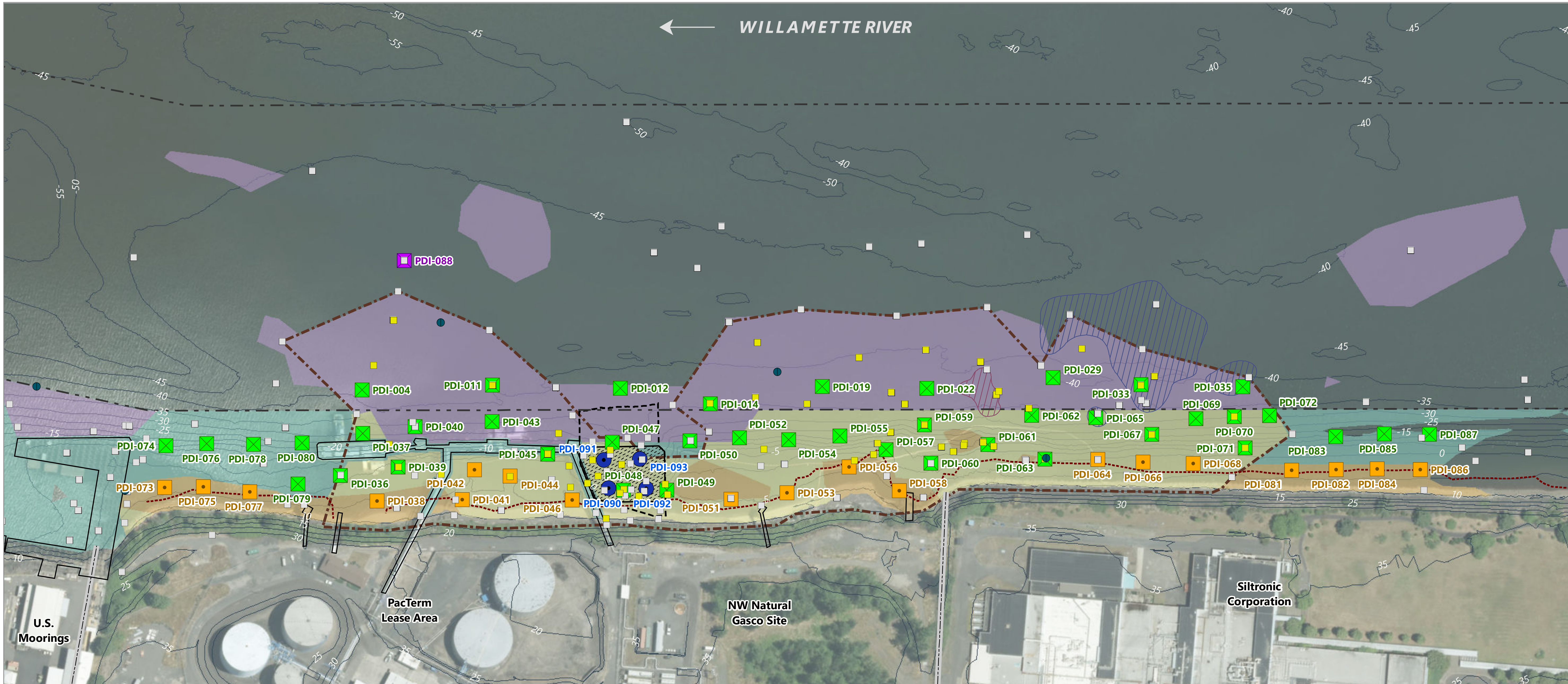
Figure A-7
Proposed Dredge Material Waste Suitability Characterization Cores
Pre-Remedial Design Data Gaps Field Sampling Plan
Gasco Sediments Cleanup Action



LEGEND:

- Navigation Channel
- Structures
- Property Line
- Tar Body Removal Action Area (RAPP, Anchor 2005)
- Tar Body Removal Action Pilot Cap
- PTW-NAPL Boundary
- Elevation (feet COP)
- Approximate Riprap Boundary [1]

ROD SMA Technology[2]

- Cap
- Dredge
- Dredge in Nav-FMD
- Dredge with Cap
- 2010 Transition Zone Water Vinyl Chloride Area 1 Boundary (Anchor QEA 2012)[3]
- Area 2 – Detected CVOCs in TZW and One Subsurface Sediment Location[4]

- Pre-RD Group Harborwide Monitoring Subsurface Sample Location (AECOM and Geosyntec 2018a)
- Existing Cores with Previously Observed PTW-NAPL
- Existing Subsurface Sample Location

Proposed Additional Analyses Locations

- 0-1 ft
- 0-2 ft, 2-4 ft, 4-6 ft, and 6-8 ft
- 0-2 ft, 2-5 ft, and 5-7 ft[5]
- 1-2 ft, 2-3 ft, and 3-4 ft

NOTES:

1. Estimated from side scan sonar survey conducted by Blue Water Engineering April 2011.
2. All depicted SMA technology and PTW contours taken from the Portland Harbor Superfund Site Record of Decision (2017) without application of the EPA Explanation of Significant Differences (ESD; EPA 2018), which is not yet finalized.
3. Boundary taken from Draft Engineering Evaluation/Cost Analysis, Appendix A, Figure 4.2. Transition zone water screening level exceedances of cis-1,2-dichloroethene identified within this vinyl chloride boundary.
4. Boundary taken from Gasco Sediments Site Statement of Work, Figure 1 (EPA 2009).
5. The nearshore core locations may need to be adjusted further offshore depending on the river elevations during sample collection to facilitate vessel access.
6. Bathymetry surveyed by DEA 2018. Topography surveyed by Geometrix 2011.
7. Arrow indicates direction of flow of river.
8. Horizontal datum is NAD83 (HARN 91) Oregon State Plane North, International Feet.
9. Vertical datum is City of Portland (COP), Feet.
10. Aerial imagery from City of Portland 2016.

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Figure A-8
Proposed Additional Analyses Locations for Non-Site-Specific COCs
Pre-Remedial Design Data Gaps Field Sampling Plan
Gasco Sediments Cleanup Action

LEGEND:

- Navigation Channel
- Structures
- Property Line
- Tar Body Removal Action Area (RAPP, Anchor 2005)
- Tar Body Removal Action Pilot Cap
- PTW-NAPL Boundary
- Elevation (feet COP)
- Approximate Riprap Boundary[1]

ROD SMA Technology[2]

- Cap
- Dredge
- Dredge in Nav-FMD
- Dredge with Cap
- 2010 Transition Zone Water Vinyl Chloride Area 1 Boundary (Anchor QEA 2012)[3]
- Area 2 – Detected CVOCs in TZW and One Subsurface Sediment Location[4]

- Cores Less Than 15 Feet Long

Percent Recovery (Cores 15 feet or longer)

- 33% - 50%
- 51% - 60%
- 61% - 70%
- 71% - 80%
- 81% - 100%

NOTES:

1. Estimated from side scan sonar survey conducted by Blue Water Engineering April 2011.
2. All depicted SMA technology and PTW contours taken from the Portland Harbor Superfund Site Record of Decision (2017) without application of the EPA Explanation of Significant Differences (ESD; EPA 2018), which is not yet finalized.
3. Boundary taken from Draft Engineering Evaluation/Cost Analysis, Appendix A, Figure 4.2. Transition zone water screening level exceedances of cis-1,2-dichloroethene identified within this vinyl chloride boundary.
4. Boundary taken from Gasco Sediments Site Statement of Work, Figure 1 (EPA 2009).
5. Bathymetry surveyed by DEA 2018. Topography surveyed by Geometrix 2011.
6. Arrow indicates direction of flow of river.
7. Horizontal datum is NAD83 (HARN 91) Oregon State Plane North, International Feet.
8. Vertical datum is City of Portland (COP), Feet.
9. Aerial imagery from City of Portland 2016.

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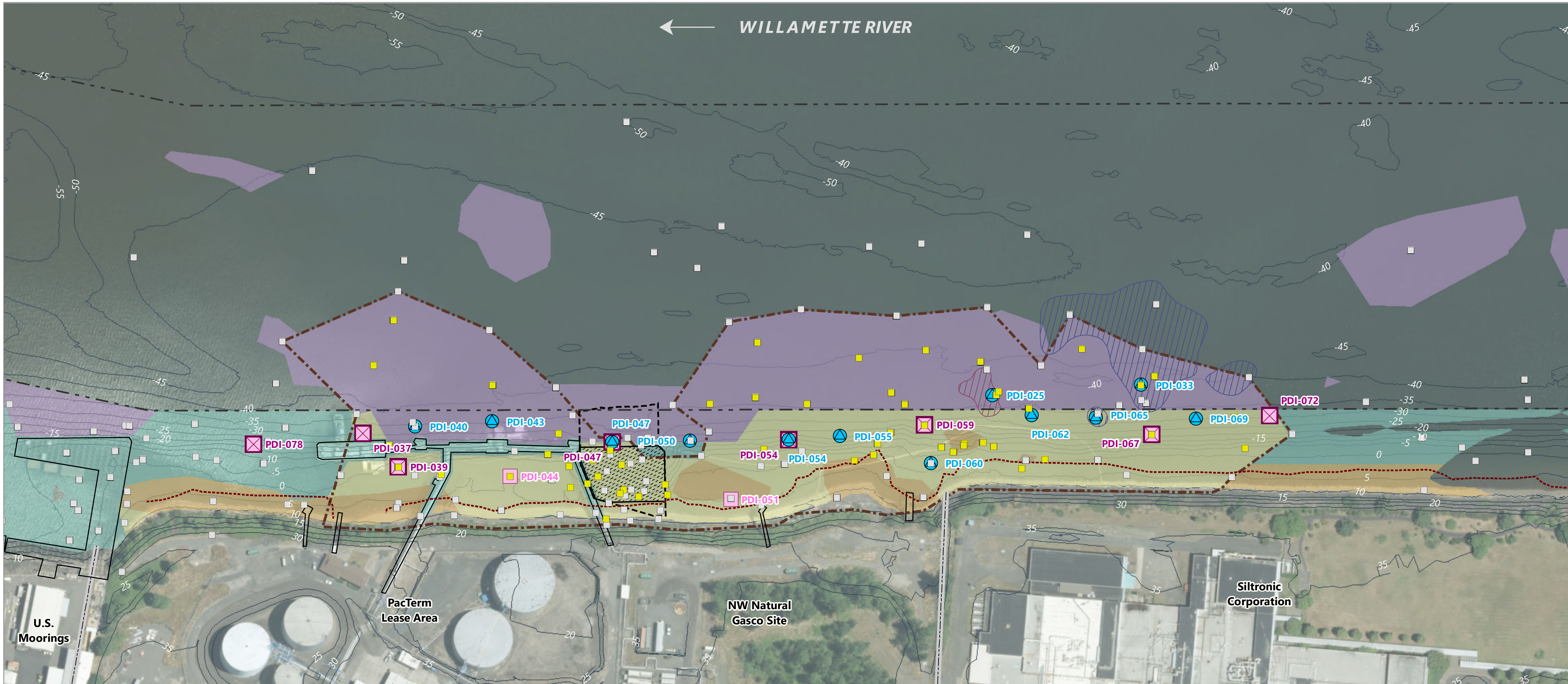
Figure A-9
Percent Recovery of Subsurface Cores Longer than 15 Feet
Pre-Remedial Design Data Gaps Field Sampling Plan
Gasco Sediments Cleanup Action



LEGEND:

Navigation Channel
Structures
Property Line
Tar Body Removal Action Area (RAPP, Anchor 2005)
Tar Body Removal Action Pilot Cap
PTW-NAPL Boundary
Elevation (feet COP)
Approximate Riprap Boundary [1]

ROD SMA Technology[2]

Cap
Dredge
Dredge in Nav-FMD
Dredge with Cap
2010 Transition Zone Water Vinyl Chloride Area 1 Boundary (Anchor QEA 2012)[3]
Area 2 – Detected CVOCs in TZW and One Subsurface Sediment Location[4]

Existing Cores with Previously Observed PTW-NAPL
Existing Cores without Observed PTW-NAPL
Proposed Paired Subsurface and Porewater Sampling Locations

Proposed Biogas Generation Potential Sampling Locations[5,6]

6-8 ft Interval
5-7 ft Interval

NOTES:

1. Estimated from side scan sonar survey conducted by Blue Water Engineering April 2011.
2. All depicted SMA technology and PTW contours taken from the Portland Harbor Superfund Site Record of Decision (2017) without application of the EPA Explanation of Significant Differences (ESD; EPA 2018), which is not yet finalized.
3. Boundary taken from Draft Engineering Evaluation/Cost Analysis, Appendix A, Figure 4.2. Transition zone water screening level exceedances of cis-1,2-dichloroethene identified within this vinyl chloride boundary.
4. Boundary taken from Gasco Sediments Site Statement of Work, Figure 1 (EPA 2009).
5. Potentially deeper samples will be collected if PTW-NAPL is identified. NAPL mobility testing may be conducted based on PTW-NAPL observations in deeper intervals.
6. The nearshore core locations may need to be adjusted further offshore depending on the river elevations during sample collection to facilitate vessel access.
7. Bathymetry surveyed by DEA 2018. Topography surveyed by Geometrix 2011.
8. Arrow indicates direction of flow of river.
9. Horizontal datum is NAD83 (HARN 91) Oregon State Plane North, International Feet.
10. Vertical datum is City of Portland (COP), Feet.
11. Aerial imagery from City of Portland 2016.

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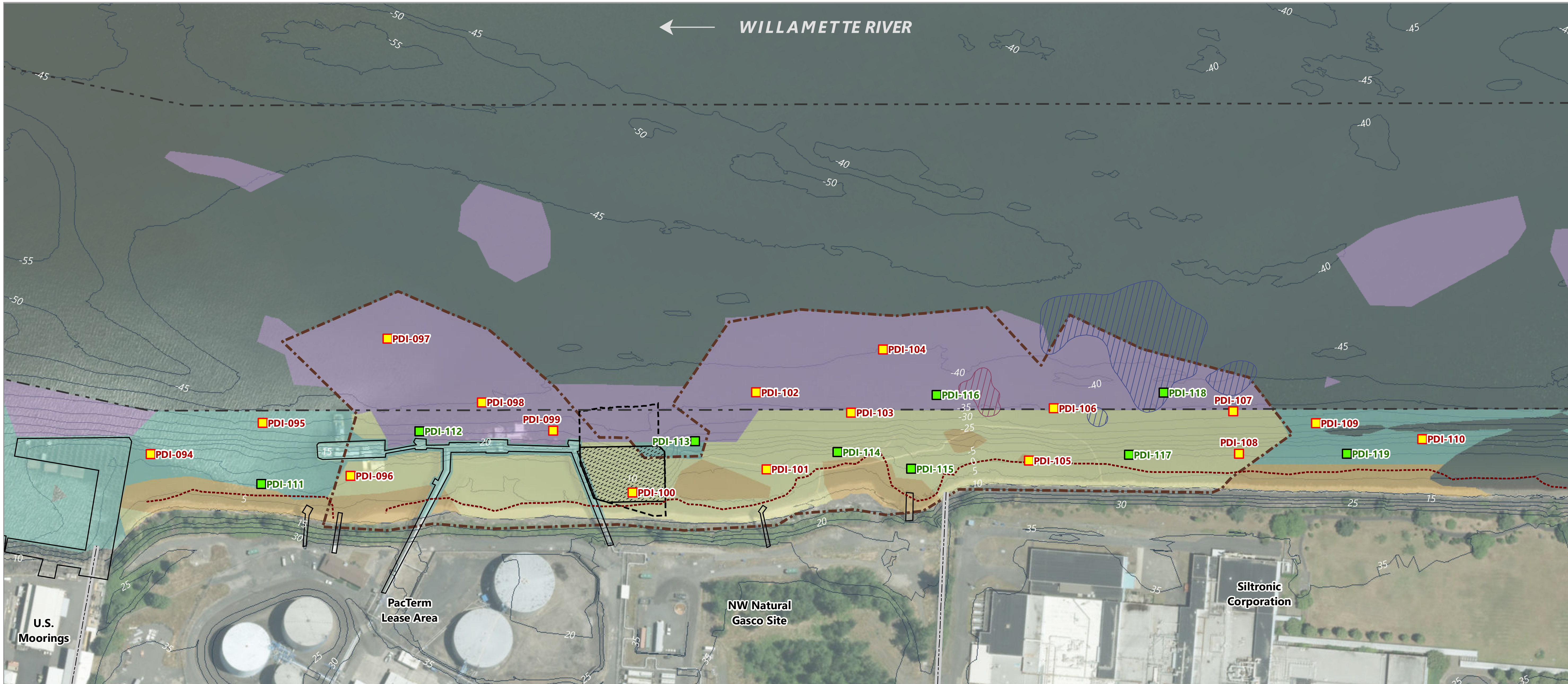
Figure A-10
Proposed Paired Subsurface Sediment and Porewater and Biogas Generation Potential Sampling Locations
Pre-Remedial Design Data Gaps Field Sampling Plan
Gasco Sediments Cleanup Action



LEGEND:

- Navigation Channel
- Structures
- Property Line
- Tar Body Removal Action Area (RAPP, Anchor 2005)
- Tar Body Removal Action Pilot Cap
- PTW-NAPL Boundary
- Elevation (feet COP)
- Approximate Riprap Boundary[1]

ROD SMA Technology[2]

- Cap
- Dredge
- Dredge in Nav-FMD
- Dredge with Cap
- 2010 Transition Zone Water Vinyl Chloride Area 1 Boundary (Anchor QEA 2012)[3]
- Area 2 – Detected CVOCs in TZW and One Subsurface Sediment Location[4]

- Proposed Sonic Core with Standard Penetration Test[5]
- Proposed In Situ Penetration Test[5]

NOTES:

1. Estimated from side scan sonar survey conducted by Blue Water Engineering April 2011.
2. All depicted SMA technology and PTW contours taken from the Portland Harbor Superfund Site Record of Decision (2017) without application of the EPA Explanation of Significant Differences (ESD; EPA 2018), which is not yet finalized.
3. Boundary taken from Draft Engineering Evaluation/Cost Analysis, Appendix A, Figure 4.2. Transition zone water screening level exceedances of cis-1,2-dichloroethene identified within this vinyl chloride boundary.
4. Boundary taken from Gasco Sediments Site Statement of Work, Figure 1 (EPA 2009).
5. The nearshore locations may be adjusted further toward of riverbank depending on the river elevations during sample collection if vessel access allows.
6. Bathymetry surveyed by DEA 2018. Topography surveyed by Geometrix 2011.
7. Arrow indicates direction of flow of river.
8. Horizontal datum is NAD83 (HARN 91) Oregon State Plane North, International Feet.
9. Vertical datum is City of Portland (COP), Feet.
10. Aerial imagery from City of Portland 2016.

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Figure A-11
Proposed Geotechnical Explorations
Pre-Remedial Design Data Gaps Field Sampling Plan
Gasco Sediments Cleanup Action

Appendix J
Summary of Core Processing Procedures – Gasco Sediments Site

Summary of Core Processing Procedures – Gasco Sediments Site

Developed by

Ryan Barth, PE, and Joe Smith

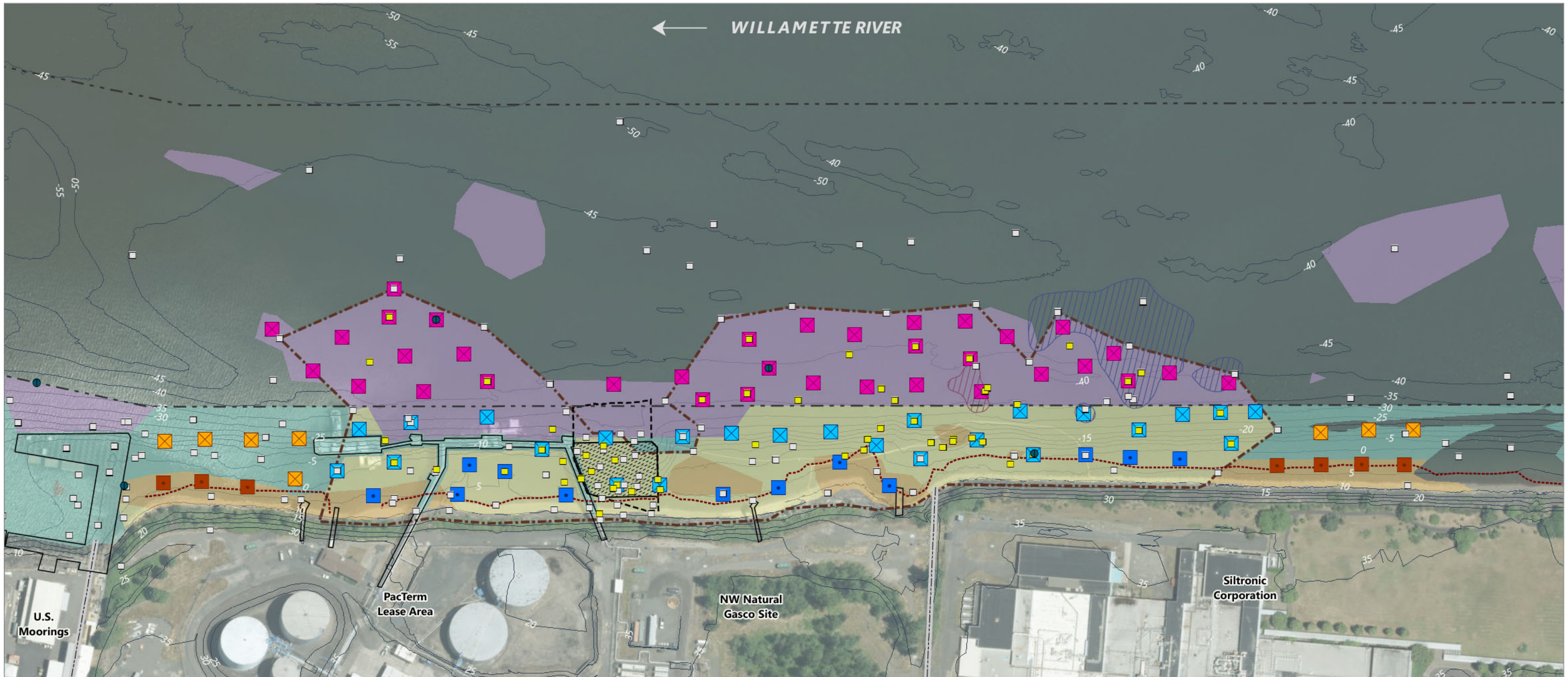
July 22, 2019

ANCHOR QEA

Introduction

- Review of data gaps subsurface sediment sampling program objectives
  - Two co-located cores (Core 1 and Core 2)
    - Capping demonstration (87 locations)
    - Additional analyses (62 locations)
    - Paired volatile organic compound (VOC) bulk sediment and porewater (12 locations)
    - Biogas generation potential (10 locations)
    - Principal threat waste nonaqueous phase liquid (PTW-NAPL) refinement and depth of contamination (DOC; 72 locations)
    - Barge dewatering and dredge material stabilization (12 locations)
    - Disposal suitability (12 locations)
  - Single core (Core 3) co-located with Core 1
    - PTW-NAPL mobility (up to 6 locations based on field observations of Core 1)
- Sample location plan view for each objective
- Core processing schematic for each objective
- Brief summary of other sampling activities

Capping Demonstration Core Locations



LEGEND:

- Navigation Channel
- Structures
- Property Line
- Tar Body Removal Action Area (RAPP, Anchor 2005)
- Tar Body Removal Action Pilot Cap
- PTW-NAPL Boundary
- Elevation (feet COP)
- Approximate Riprap Boundary[1]

ROD SMA Technology[2]

- Cap
- Dredge
- Dredge in Nav-FMD
- Dredge with Cap
- 2010 Transition Zone Water Vinyl Chloride Area 1 Boundary (Anchor QEA 2012)[3]
- Area 2 – Detected CVOCs in TZW and One Subsurface Sediment Location[4]

- Pre-RD Group Harborwide Monitoring Subsurface Sample Location (AECOM and Geosyntec 2018a)
- Existing Cores with Previously Observed PTW-NAPL
- Existing Subsurface Sample Location

Proposed Capping Only Cores

- Consecutive 2-ft Intervals Throughout Core Penetration Depth
- 0-2 ft, 2-5 ft, 5-7 ft, 7-10 ft, and 10-13 ft Intervals[5,6]

Proposed Dredge and Cap Cores[7]

- Consecutive 2-ft Intervals Throughout Core Penetration Depth
- 0-2 ft, 2-5 ft, 5-7 ft, 7-10 ft, and 10-13 ft Intervals[5,6]
- Consecutive 2-ft Intervals Throughout Core Penetration Depth Initiating at -47 Feet COP Elevation[8]

NOTES:

1. Estimated from side scan sonar survey conducted by Blue Water Engineering April 2011.
2. All depicted SMA technology and PTW contours taken from the Portland Harbor Superfund Site Record of Decision (2017) without application of the EPA Explanation of Significant Differences (ESD; EPA 2018), which is not yet finalized.
3. Boundary taken from Draft Engineering Evaluation/Cost Analysis, Appendix A, Figure 4.2. Transition zone water screening level exceedances of cis-1,2-dichloroethene identified within this vinyl chloride boundary.
4. Boundary taken from Gasco Sediments Site Statement of Work, Figure 1 (EPA 2009).
5. Potentially deeper samples will be collected if PTW-NAPL is identified. NAPL mobility testing may be conducted based on PTW-NAPL observations in deeper intervals.
6. The nearshore core locations may need to be adjusted further offshore depending on the river elevations during sample collection to facilitate vessel access.
7. All dredge and cap core locations are identical to DOC locations shown in Figure 5.
8. Capping in the channel becomes feasible in the navigation channel below -47 feet COP, based on ROD-identified -43 feet Columbia River Datum (CRD) authorized federal maintenance dredging elevation plus 3 feet overdredge plus 4- to 5-foot underlying cap thickness plus conversion from CRD to COP datum.
9. Bathymetry surveyed by DEA 2018. Topography surveyed by Geometrix 2011.
10. Arrow indicates direction of flow of river.
11. Horizontal datum is NAD83 (HARN 91) Oregon State Plane North, International Feet.
12. Vertical datum is City of Portland (COP), Feet.
13. Aerial imagery from City of Portland 2016.

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Filepath: \\orcas\GIS\Jobs\NW_Natural_Gas_0029\Gasco_Sediments\Maps\Reports\DataGapsWorkPlan2018\AQ_DGWP_Fig06_SubsurfaceCapModeling.mxd

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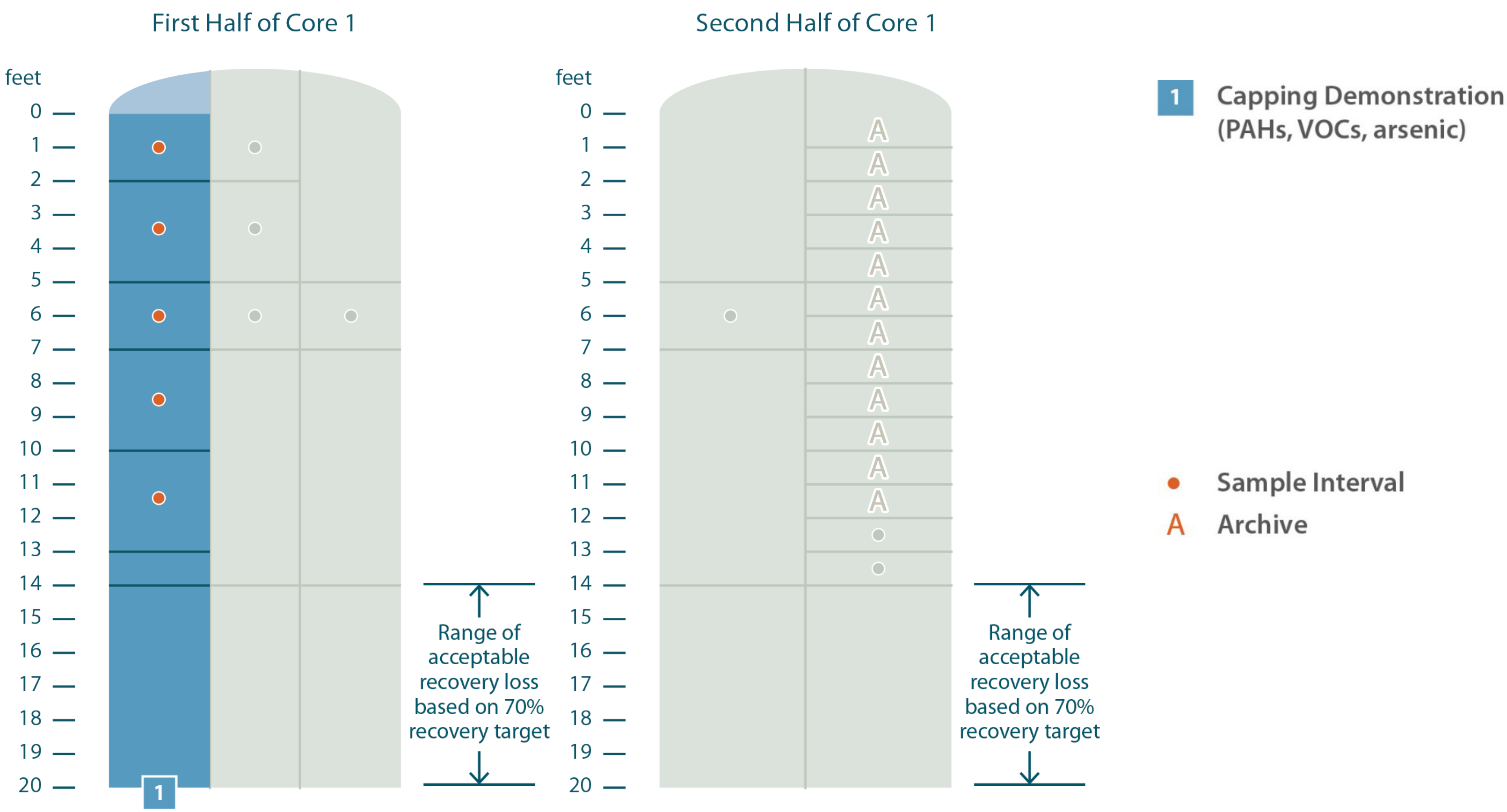
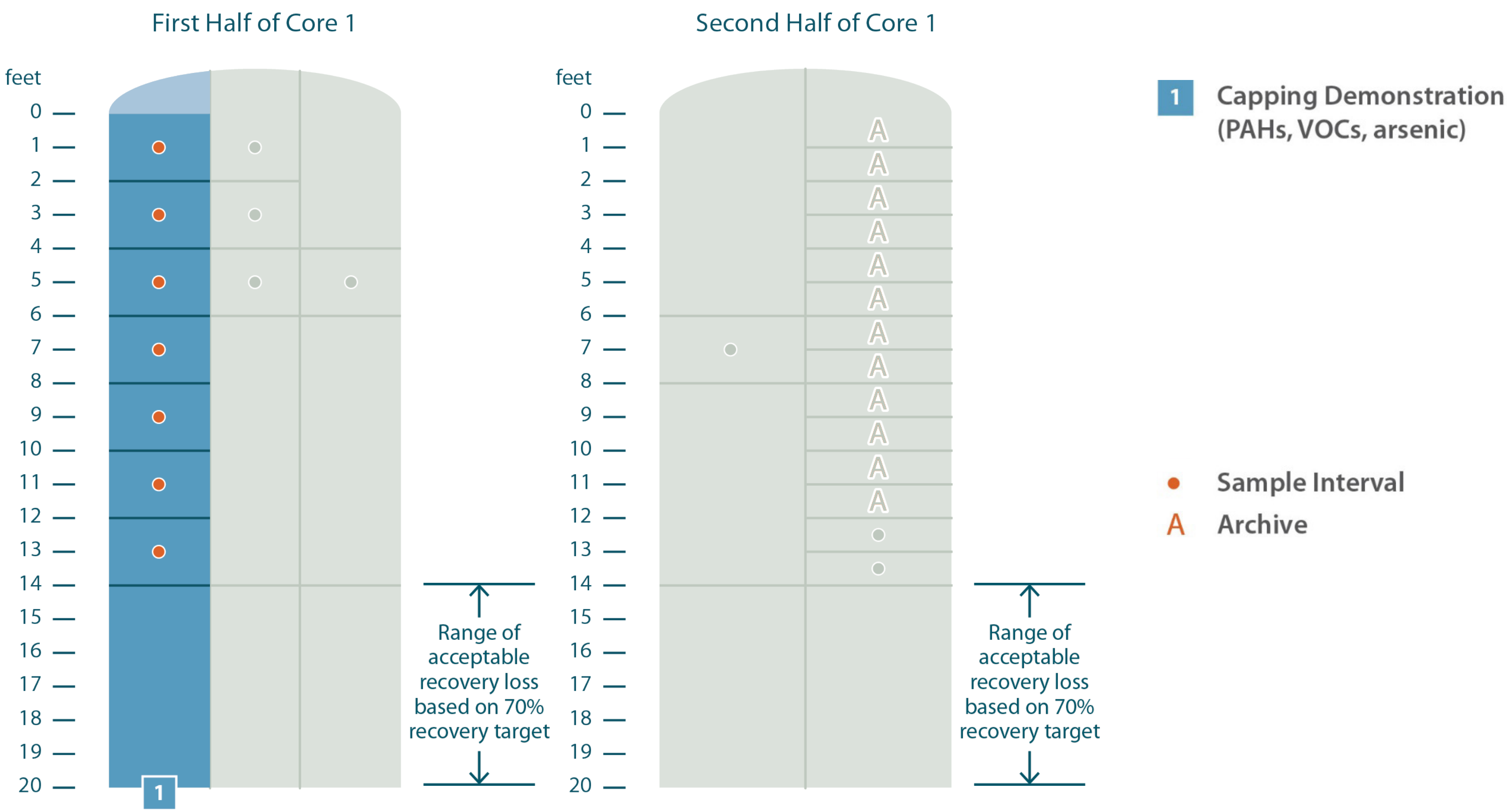
Figure 6
Proposed Subsurface Capping Demonstration Cores
Pre-Remedial Design Data Gaps Work Plan
Gasco Sediments Cleanup Action

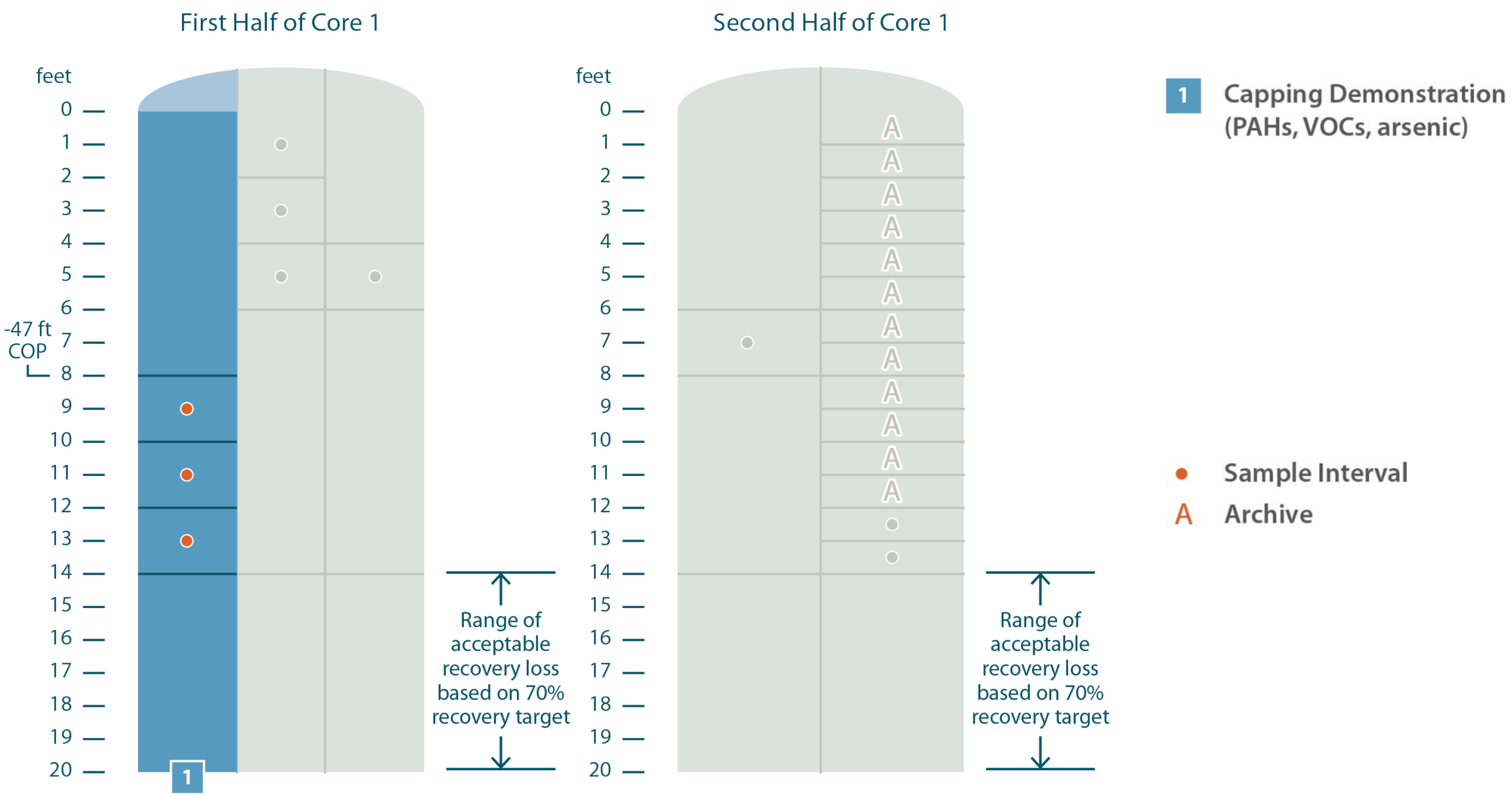
Core Processing: Nearshore Transect Outside of Navigation Channel (Shallow Region)



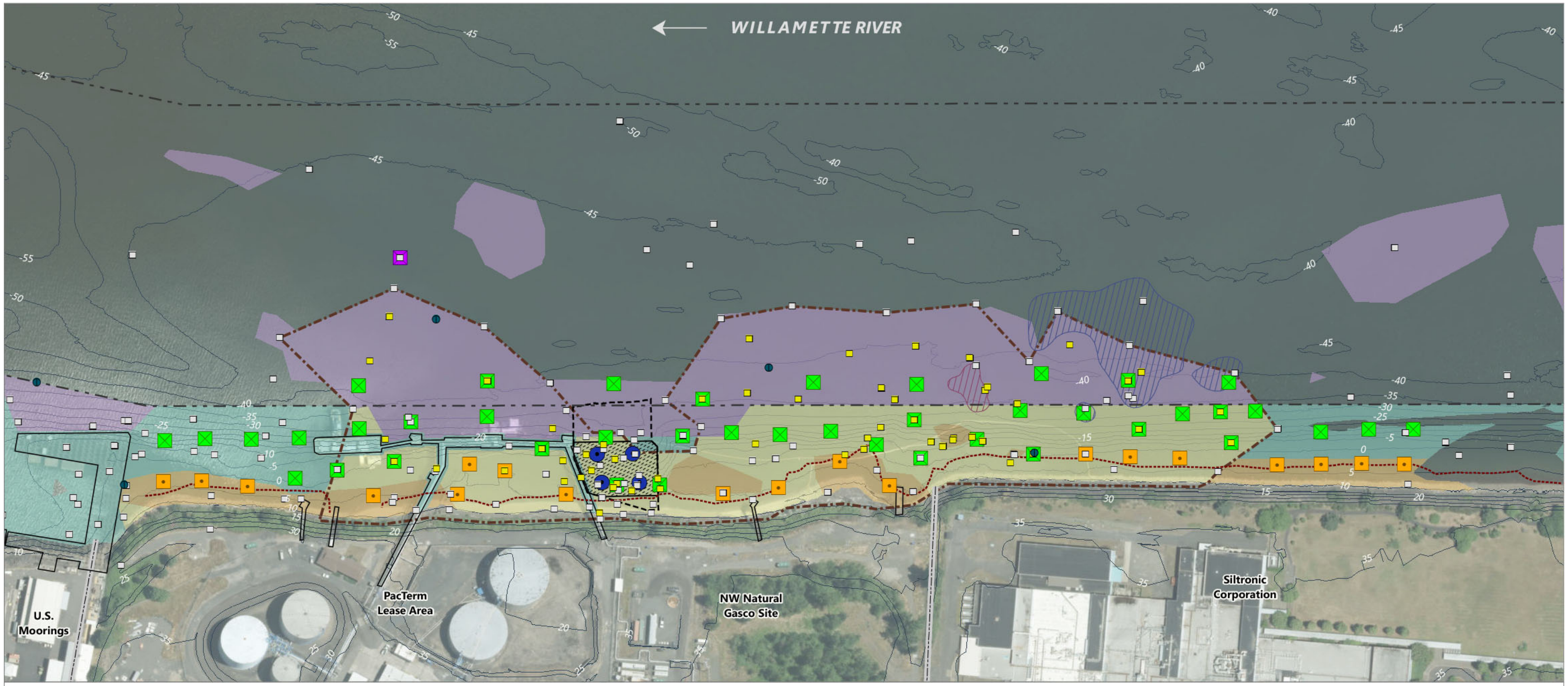
Core Processing: Offshore Transect Outside of Navigation Channel (Intermediate Region)



Core Processing: Inside Navigation Channel



Additional Analyses Core Locations



LEGEND:

- Navigation Channel
- Structures
- Property Line
- Tar Body Removal Action Area (RAPP, Anchor 2005)
- Tar Body Removal Action Pilot Cap
- PTW-NAPL Boundary
- Elevation (feet COP)
- Approximate Riprap Boundary[1]

ROD SMA Technology[2]

- Cap
- Dredge
- Dredge in Nav-FMD
- Dredge with Cap
- 2010 Transition Zone Water Vinyl Chloride Area 1 Boundary (Anchor QEA 2012)[3]
- Area 2 – Detected CVOCs in TZW and One Subsurface Sediment Location[4]

- Pre-RD Group Harborwide Monitoring Subsurface Sample Location (AECOM and Geosyntec 2018a)
- Existing Cores with Previously Observed PTW-NAPL
- Existing Subsurface Sample Location

Proposed Additional Analyses Locations

- 0-1 ft
- 0-2 ft, 2-4 ft, 4-6 ft, and 6-8 ft
- 0-2 ft, 2-5 ft, and 5-7 ft[5]
- 1-2 ft, 2-3 ft, and 3-4 ft

NOTES:

1. Estimated from side scan sonar survey conducted by Blue Water Engineering April 2011.
2. All depicted SMA technology and PTW contours taken from the Portland Harbor Superfund Site Record of Decision (2017) without application of the EPA Explanation of Significant Differences (ESD; EPA 2018), which is not yet finalized.
3. Boundary taken from Draft Engineering Evaluation/Cost Analysis, Appendix A, Figure 4.2. Transition zone water screening level exceedances of cis-1,2-dichloroethene identified within this vinyl chloride boundary.
4. Boundary taken from Gasco Sediments Site Statement of Work, Figure 1 (EPA 2009).
5. The nearshore core locations may need to be adjusted further offshore depending on the river elevations during sample collection to facilitate vessel access.
6. Bathymetry surveyed by DEA 2018. Topography surveyed by Geometrix 2011.
7. Arrow indicates direction of flow of river.
8. Horizontal datum is NAD83 (HARN 91) Oregon State Plane North, International Feet.
9. Vertical datum is City of Portland (COP), Feet.
10. Aerial imagery from City of Portland 2016.

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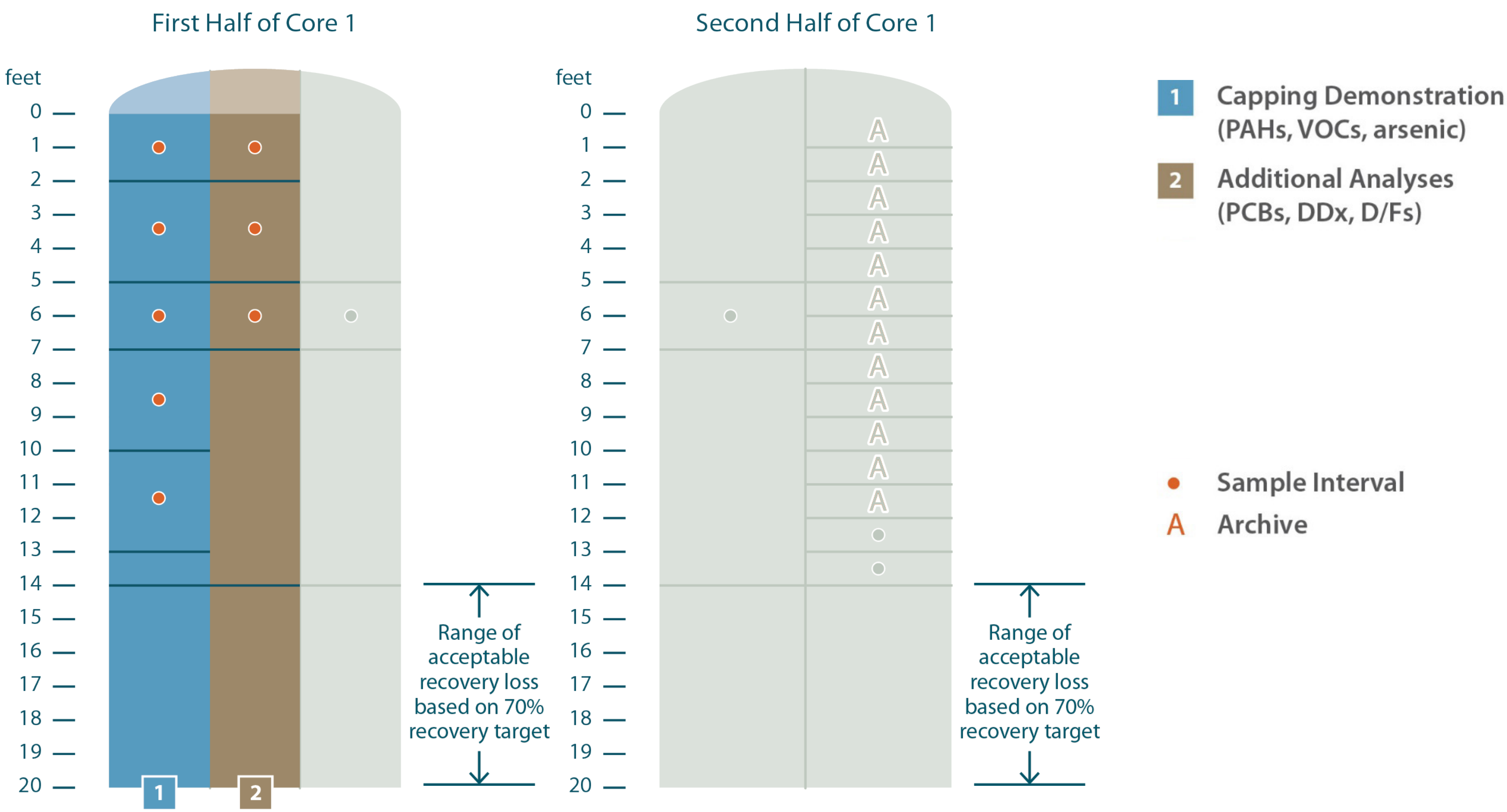
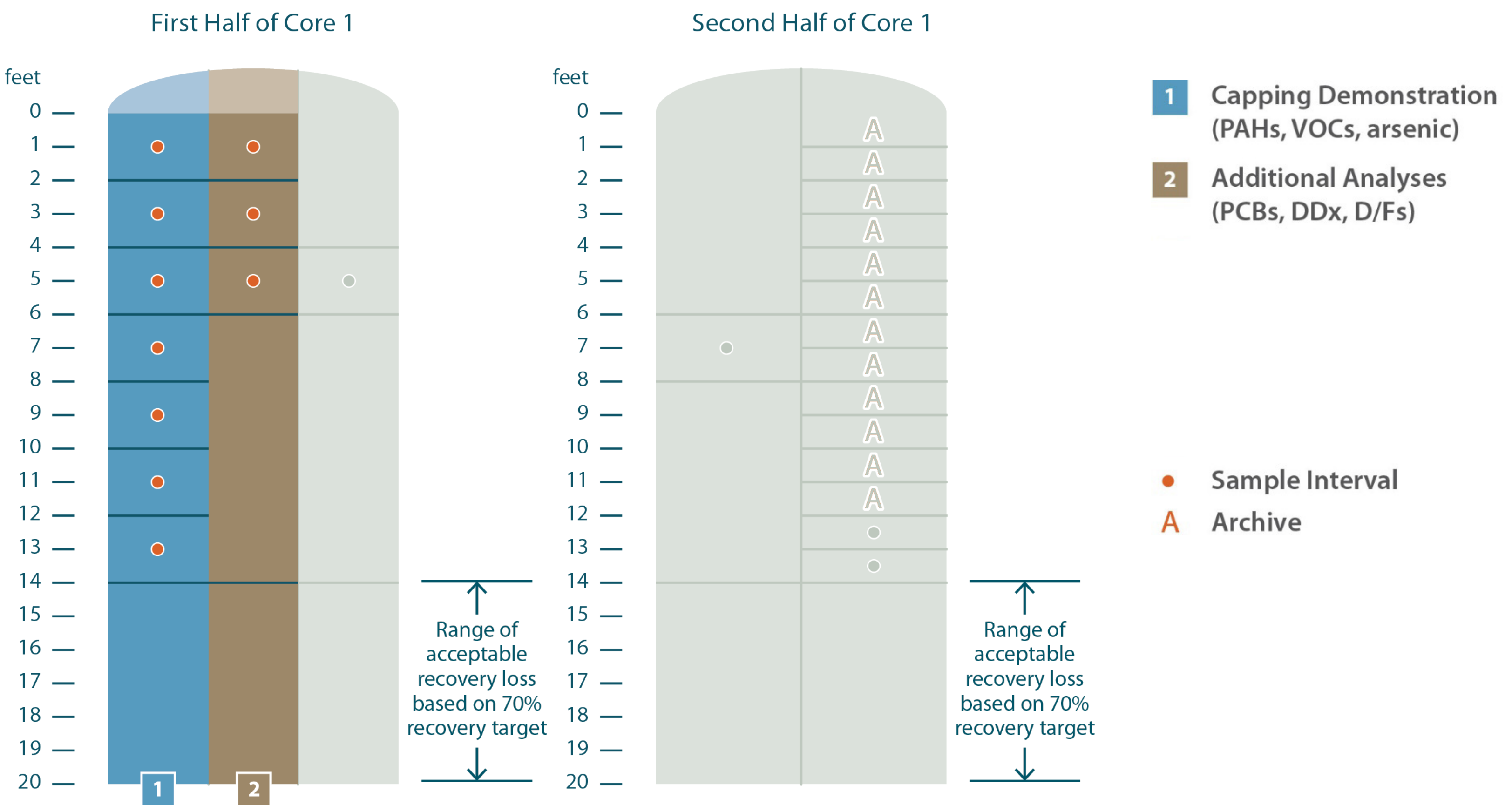
ANCHOR QEA

Figure 13
Proposed Additional Analyses Locations for Non-Site-Specific COCs
Pre-Remedial Design Data Gaps Work Plan
Gasco Sediments Cleanup Action

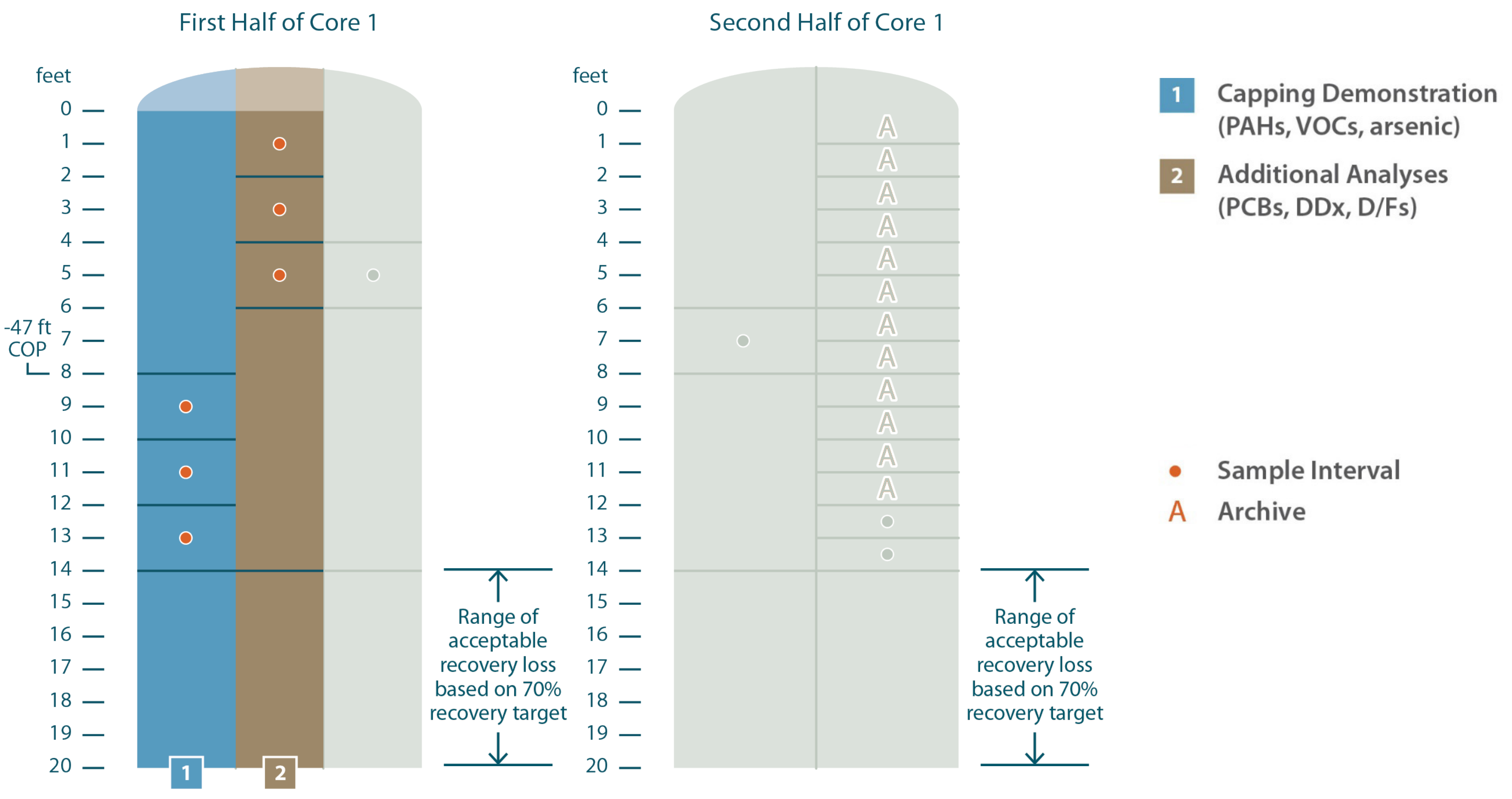
Core Processing: Nearshore Transect Outside of Navigation Channel (Shallow Region)



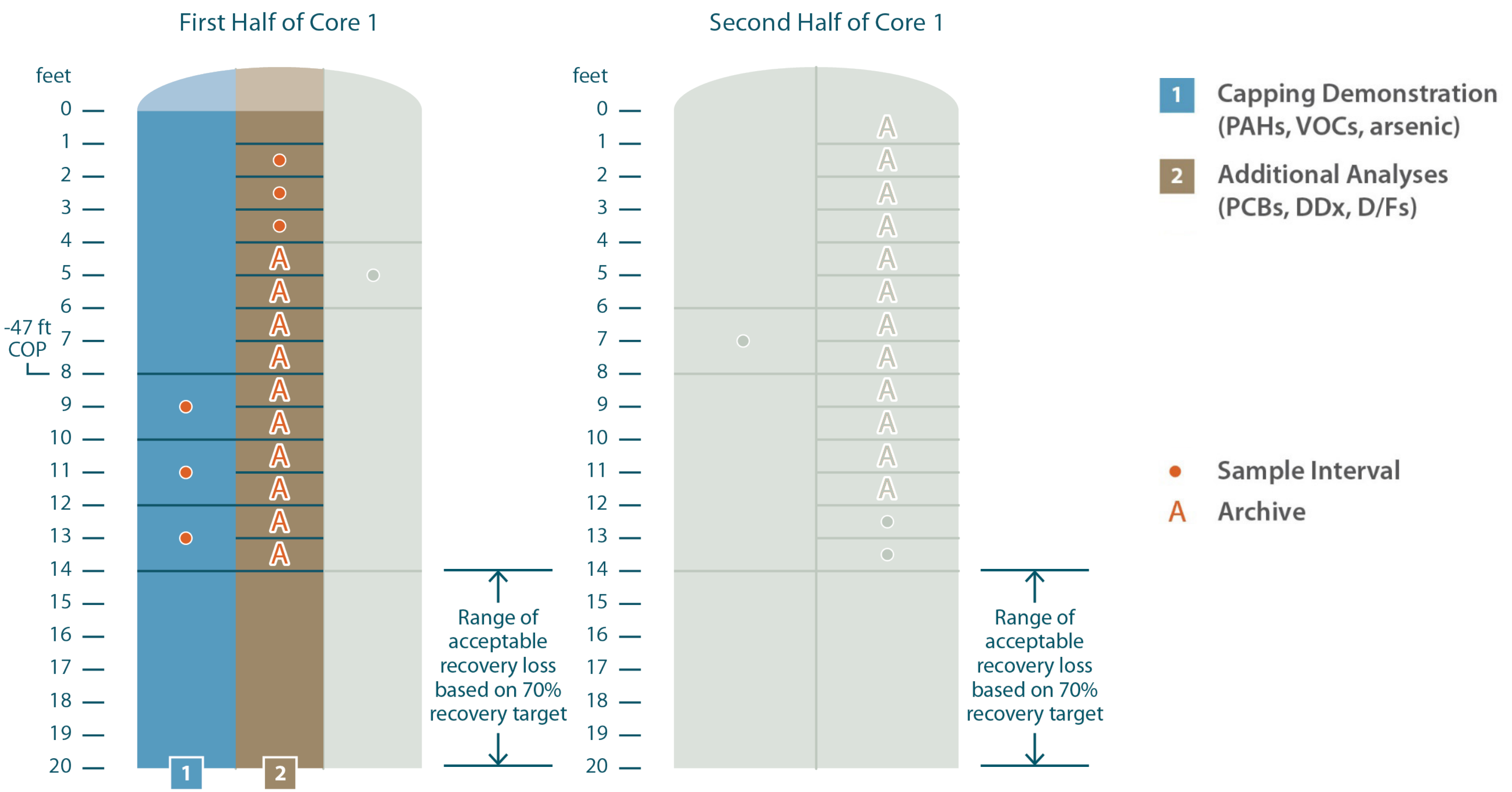
Core Processing: Offshore Transect Outside of Navigation Channel (Intermediate Region)



Core Processing: Inside Navigation Channel



Inside Navigation Channel, Outside of ROD-Identified SMAs



Paired VOC Bulk Sediment and Porewater Sample Locations

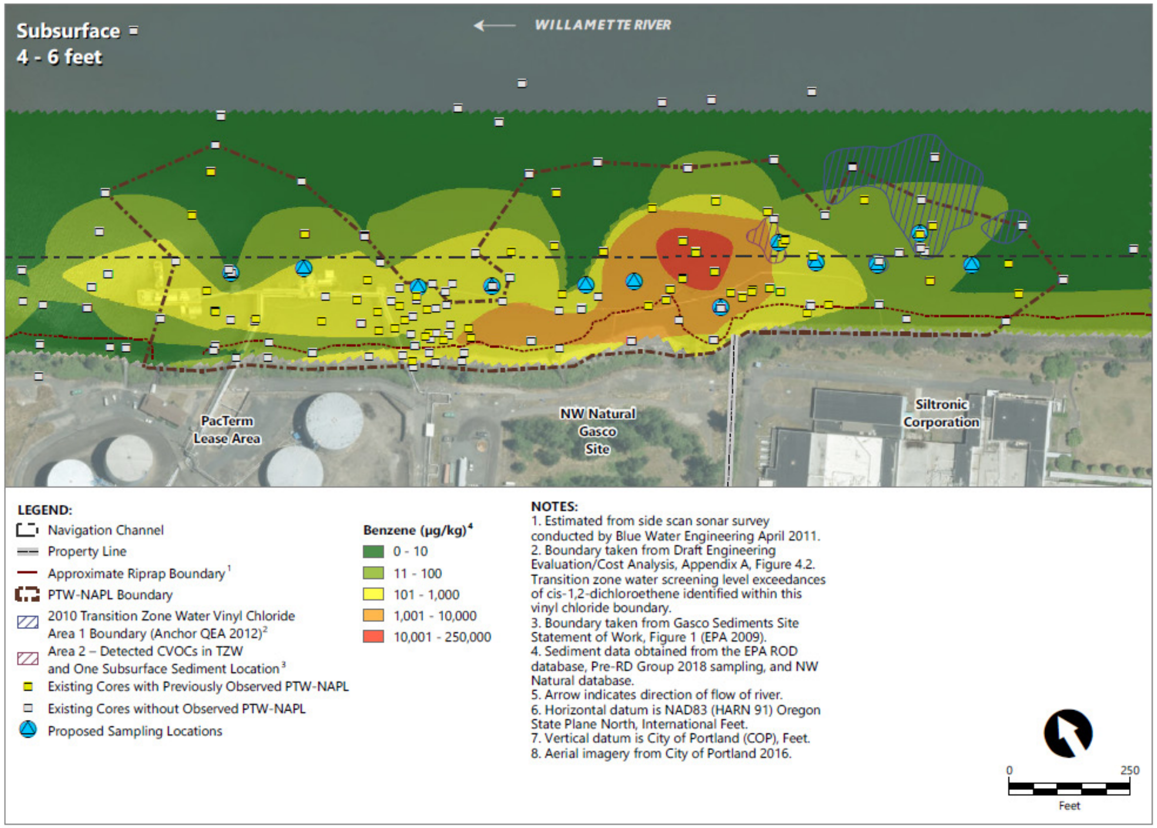


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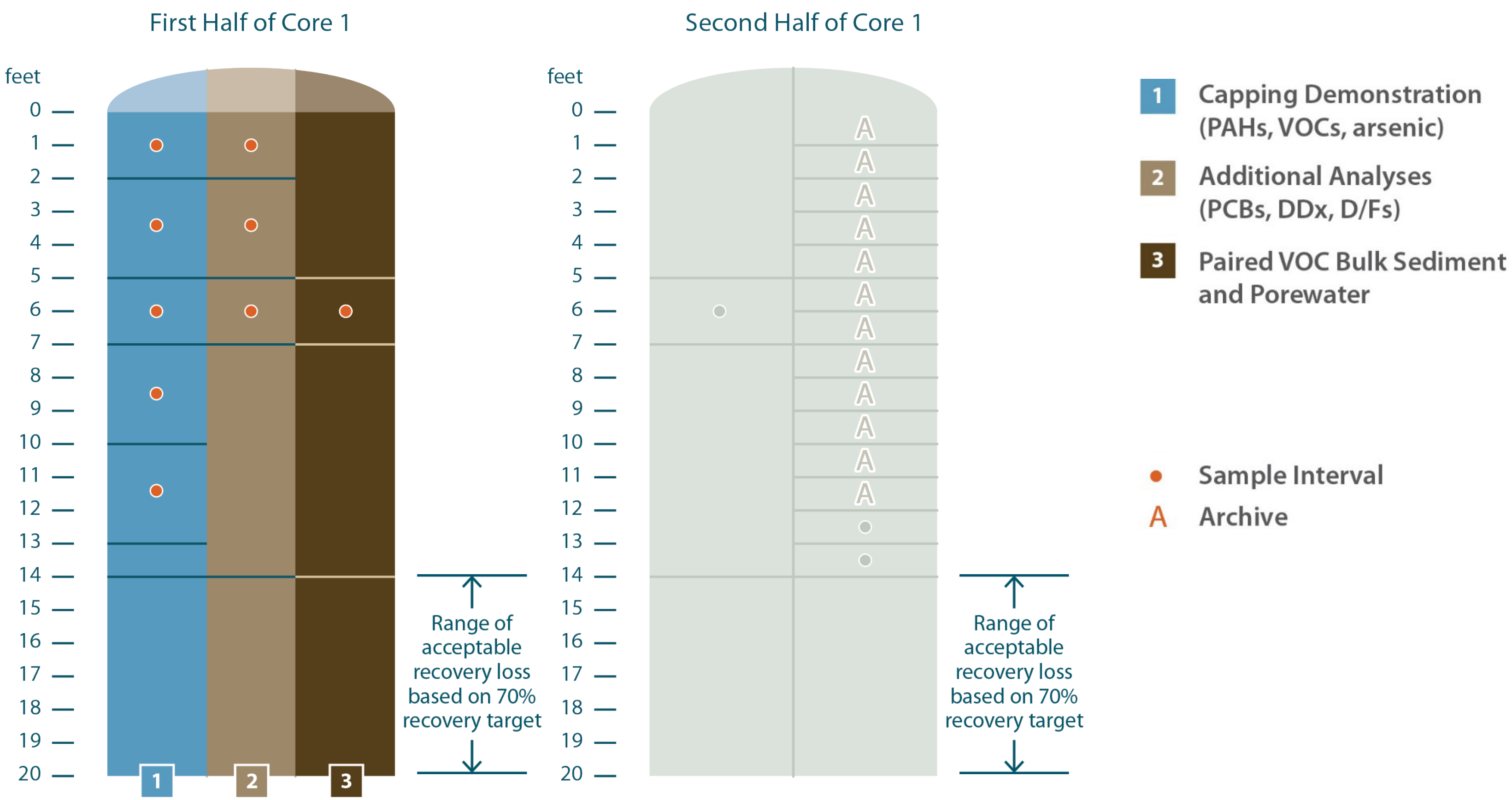
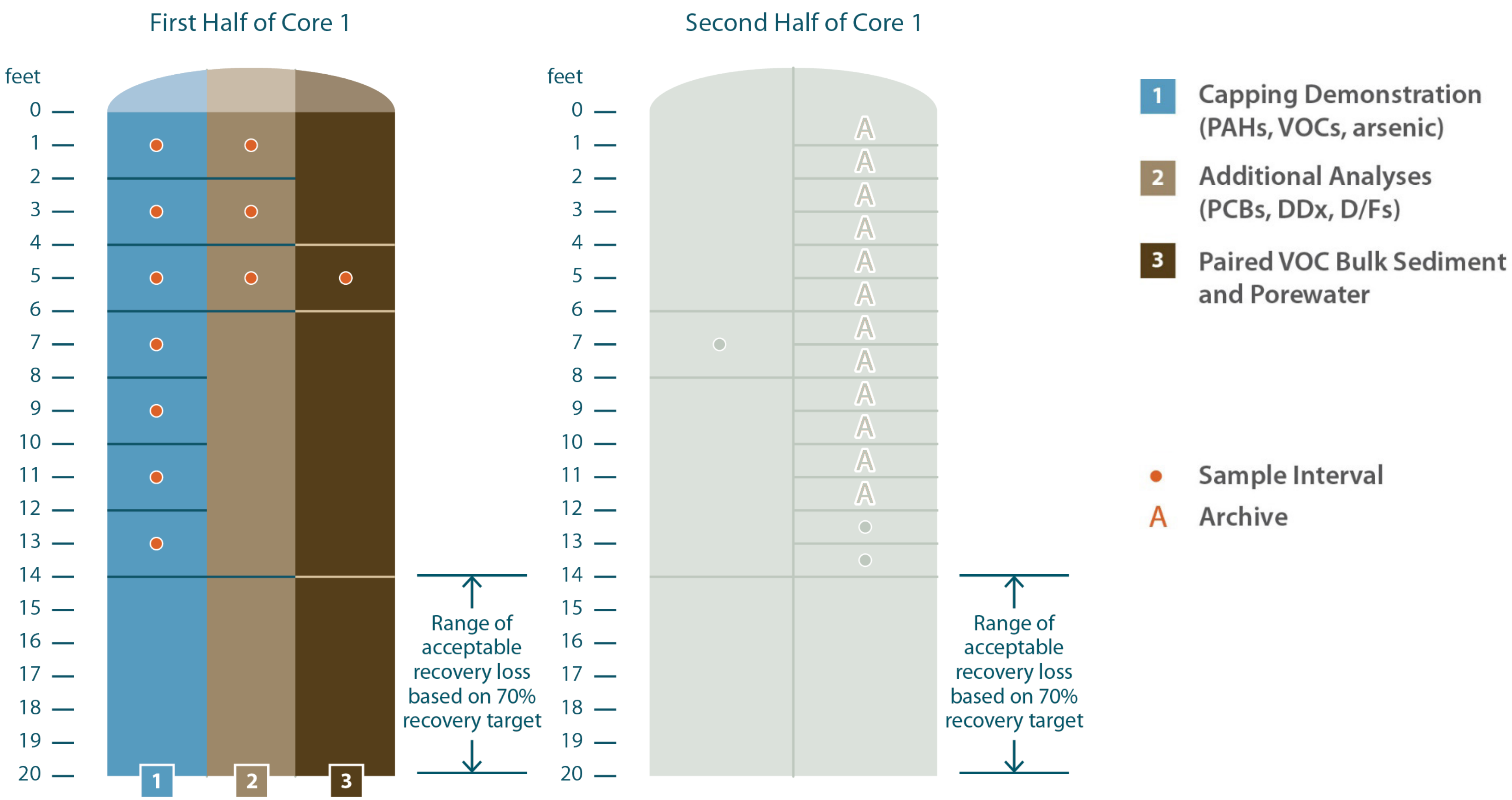
Figure E-1a
Proposed Paired Subsurface Sediment and Porewater Sampling Locations, Benzene in Sediment From 0 to 6 Feet
Supporting Figures for Paired Subsurface Sediment and Porewater and Biogas Generation Potential Locations
Gasco Sediments Cleanup Action

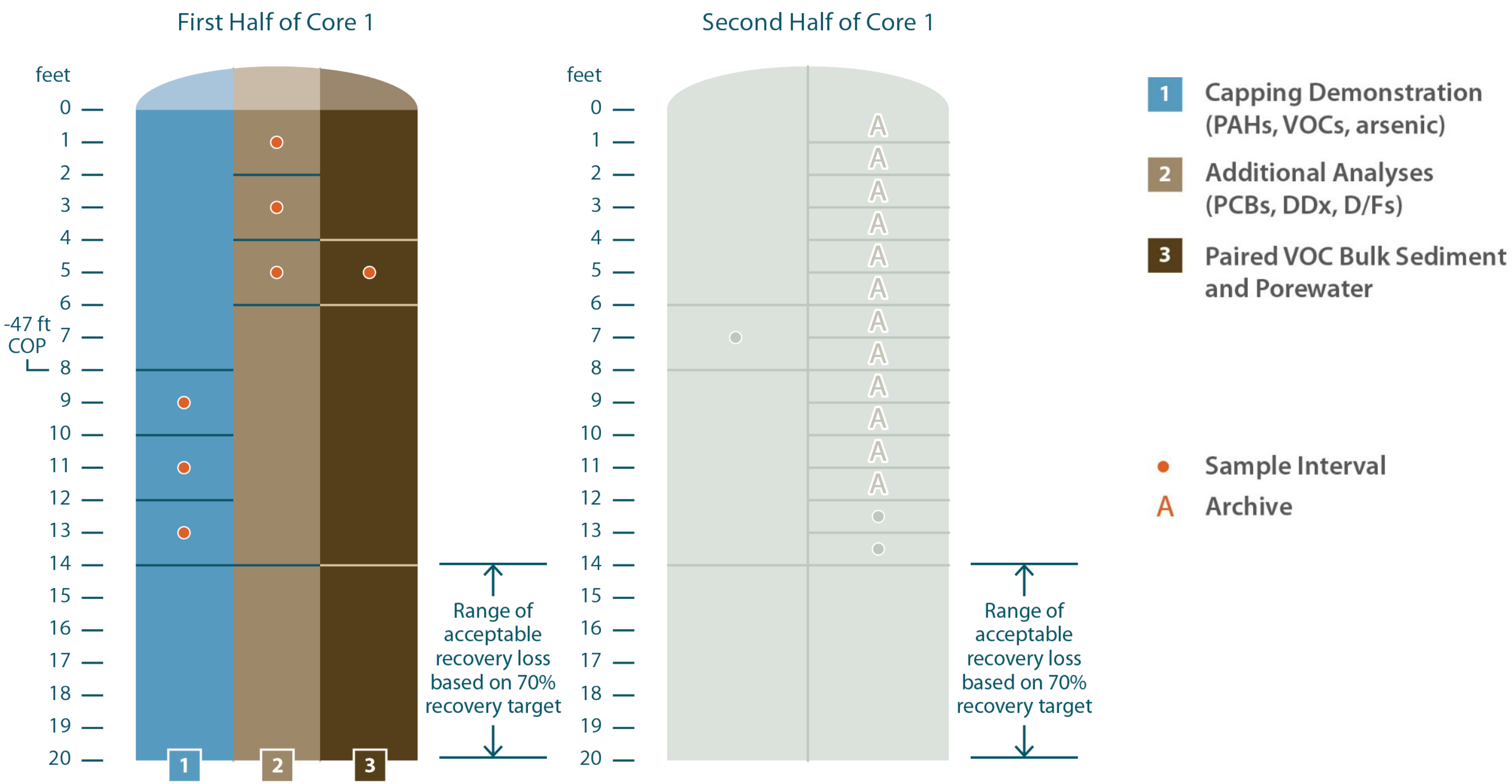
Core Processing: Nearshore Transect Outside of Navigation Channel (Shallow Region)



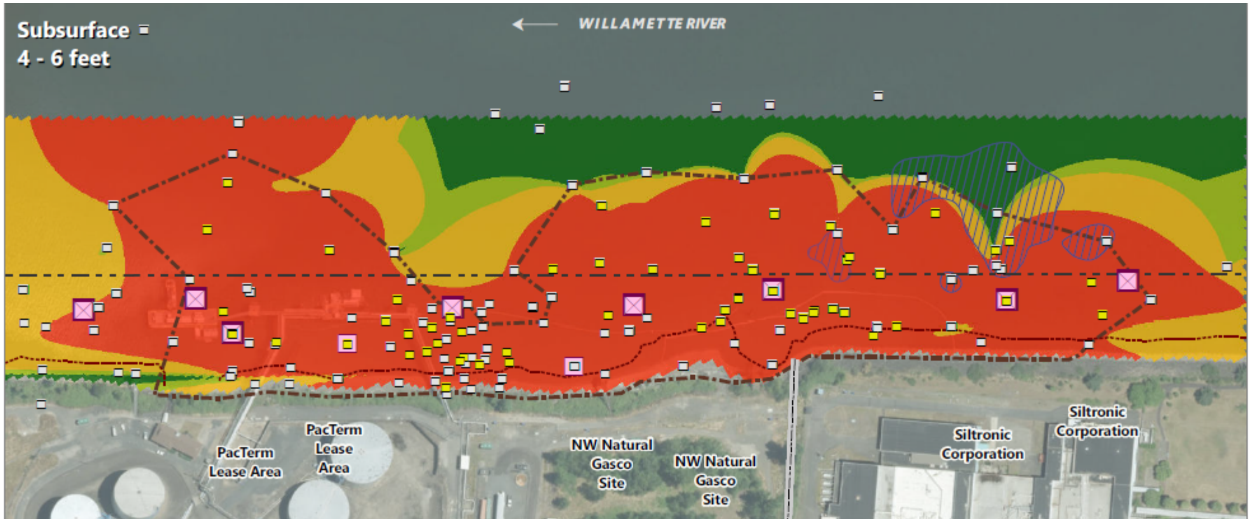
Core Processing: Offshore Transect Outside of Navigation Channel (Intermediate Region)



Core Processing: Inside Navigation Channel



Biogas Generation Potential Sample Locations



LEGEND:

- Navigation Channel
- Property Line
- Approximate Riprap Boundary[1]
- PTW-NAPL Boundary
- 2010 Transition Zone Water Vinyl Chloride Area 1 Boundary (Anchor QEA 2012)[2]
- Area 2 – Detected CVOCs in TZW and One Subsurface Sediment Location[3]
- Existing Cores with Previously Observed PTW-NAPL
- Existing Cores without Observed PTW-NAPL

Proposed Biogas Generation Potential Sampling Locations

- 6-8 ft Interval
- 5-7 ft Interval

Total PAH (µg/kg)[7]

- < 13,000
- 13,001 - 30,000
- 30,001 - 170,000
- > 170,000

NOTES:

1. Estimated from side scan sonar survey conducted by Blue Water Engineering April 2011.
2. Boundary taken from Draft Engineering Evaluation/Cost Analysis, Appendix A, Figure 4.2. Transition zone water screening level exceedances of cis-1,2-dichloroethene identified within this vinyl chloride boundary.
3. Boundary taken from Gasco Sediments Site Statement of Work, Figure 1 (EPA 2009).
4. Potentially deeper samples will be collected if PTW-NAPL is identified. NAPL mobility testing may be conducted based on PTW-NAPL observations in deeper intervals.
5. The nearshore core locations may need to be adjusted further offshore depending on the river elevations during sample collection to facilitate vessel access.
6. Sediment data obtained from the EPA ROD database, Pre-RD Group 2018 sampling, and NW Natural database.
7. Arrow indicates direction of flow of river.
8. Horizontal datum is NAD83 (HARN 91) Oregon State Plane North, International Feet.
9. Vertical datum is City of Portland (COP), Feet.
10. Aerial imagery from City of Portland 2016.

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ANCHOR QEA

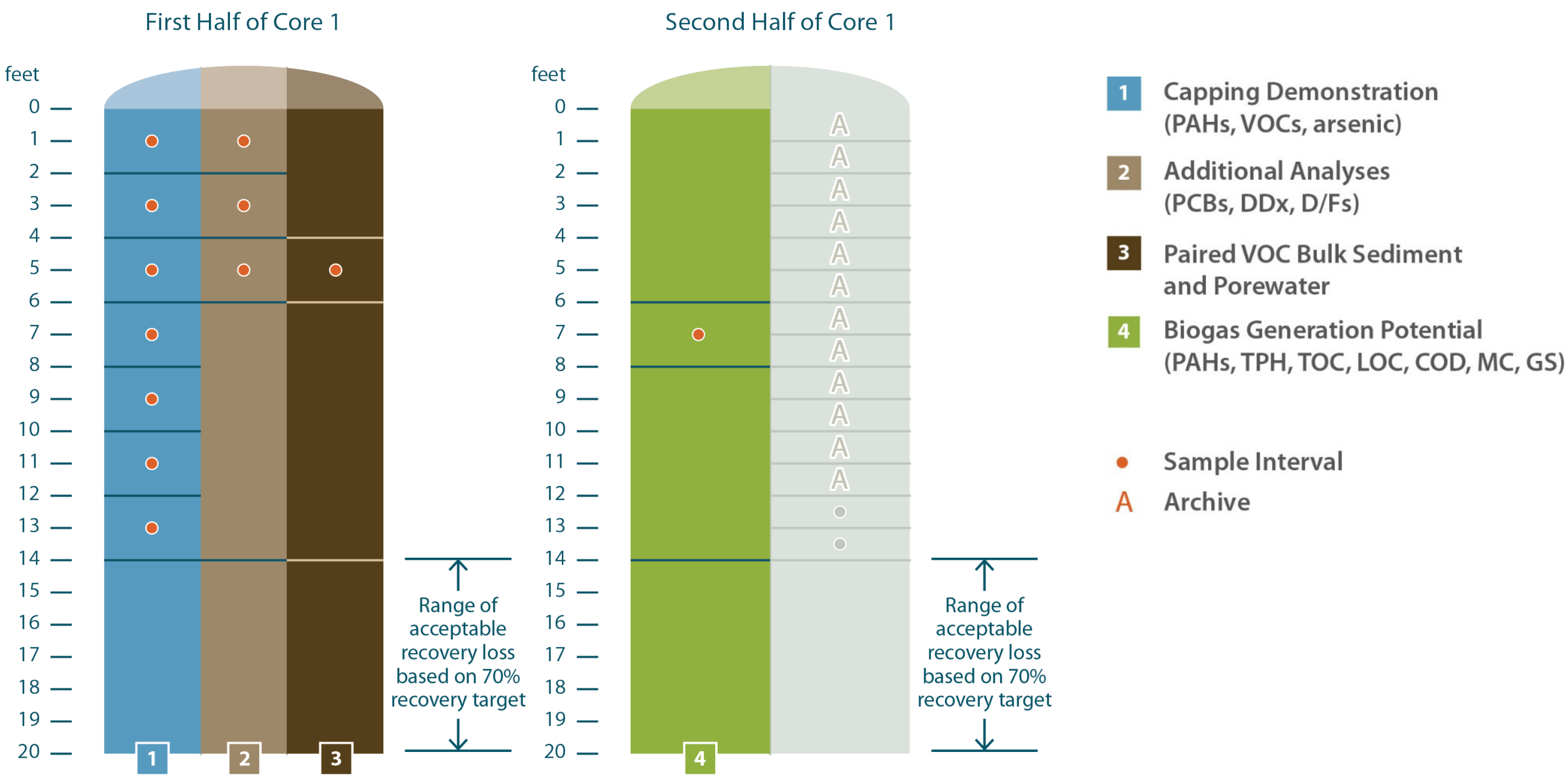
Figure E-3a

Proposed Biogas Generation Potential Sampling Locations, Total PAH in Sediment From 0 to 6 Feet

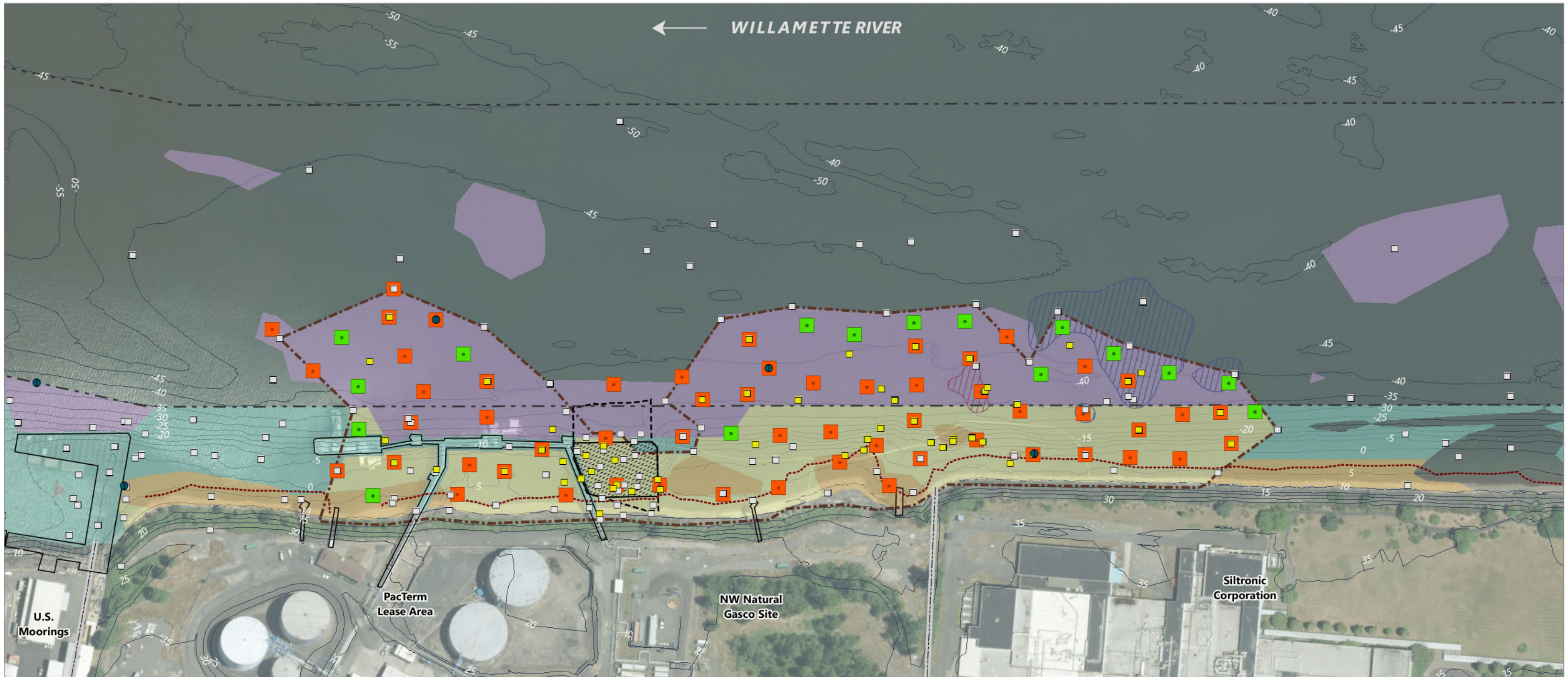
Supporting Figures for Paired Subsurface Sediment and Porewater and Biogas Generation Potential Locations
Gasco Sediments Cleanup Action

Core Processing: Nearshore Transect Outside of Navigation Channel (Shallow Region)

Core Processing: Offshore Transect Outside of Navigation Channel (Intermediate Region)



PTW-NAPL Refinement DOC Sample Locations



LEGEND:

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- Tar Body Removal Action Area (RAPP, Anchor 2005)
- Tar Body Removal Action Pilot Cap
- PTW-NAPL Boundary
- Elevation (feet COP)
- Approximate Riprap Boundary[1]

ROD SMA Technology[2]

- Cap
- Dredge
- Dredge in Nav-FMD
- Dredge with Cap
- 2010 Transition Zone Water Vinyl Chloride Area 1 Boundary (Anchor QEA 2012)[3]
- Area 2 – Detected CVOCs in TZW and One Subsurface Sediment Location[4]

- Pre-RD Group Harborwide Monitoring Subsurface Sample Location (AECOM and Geosyntec 2018a)
- Existing Cores with Previously Observed PTW-NAPL
- Existing Subsurface Sample Location
- Proposed DOC Core[5]
- Proposed DOC and PTW-NAPL Refinement Core

NOTES:

1. Estimated from side scan sonar survey conducted by Blue Water Engineering April 2011.
2. All depicted SMA technology and PTW contours taken from the Portland Harbor Superfund Site Record of Decision (2017) without application of the EPA Explanation of Significant Differences (ESD; EPA 2018), which is not yet finalized.
3. Boundary taken from Draft Engineering Evaluation/Cost Analysis, Appendix A, Figure 4.2. Transition zone water screening level exceedances of cis-1,2-dichloroethene identified within this vinyl chloride boundary.
4. Boundary taken from Gasco Sediments Site Statement of Work, Figure 1 (EPA 2009).
5. The nearshore core locations may need to be adjusted further offshore depending on the river elevations during sample collection to facilitate vessel access.
6. Bathymetry surveyed by DEA 2018. Topography surveyed by Geometrix 2011.
7. Arrow indicates direction of flow of river.
8. Horizontal datum is NAD83 (HARN 91) Oregon State Plane North, International Feet.
9. Vertical datum is City of Portland (COP), Feet.
10. Aerial imagery from City of Portland 2016.

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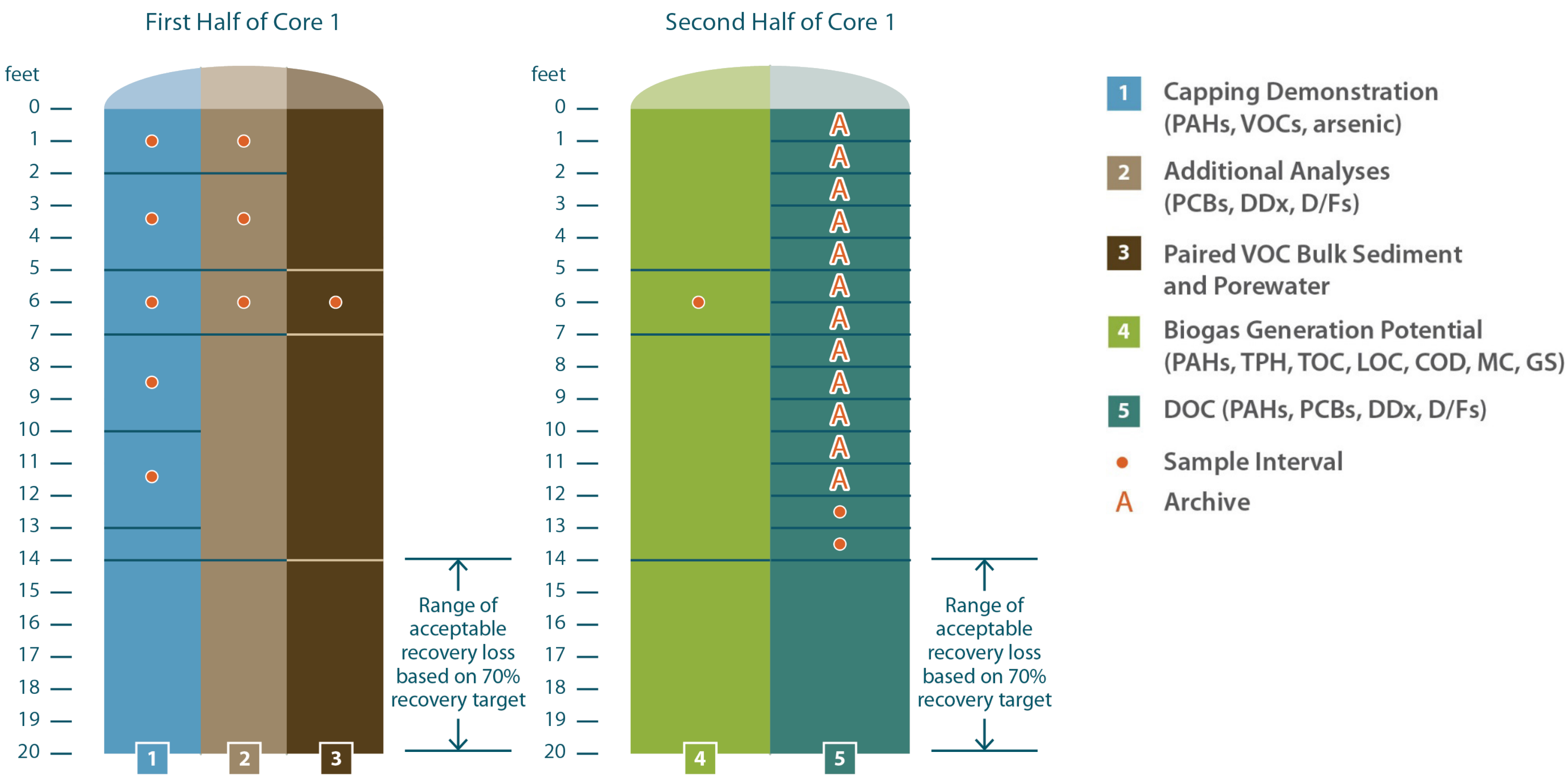
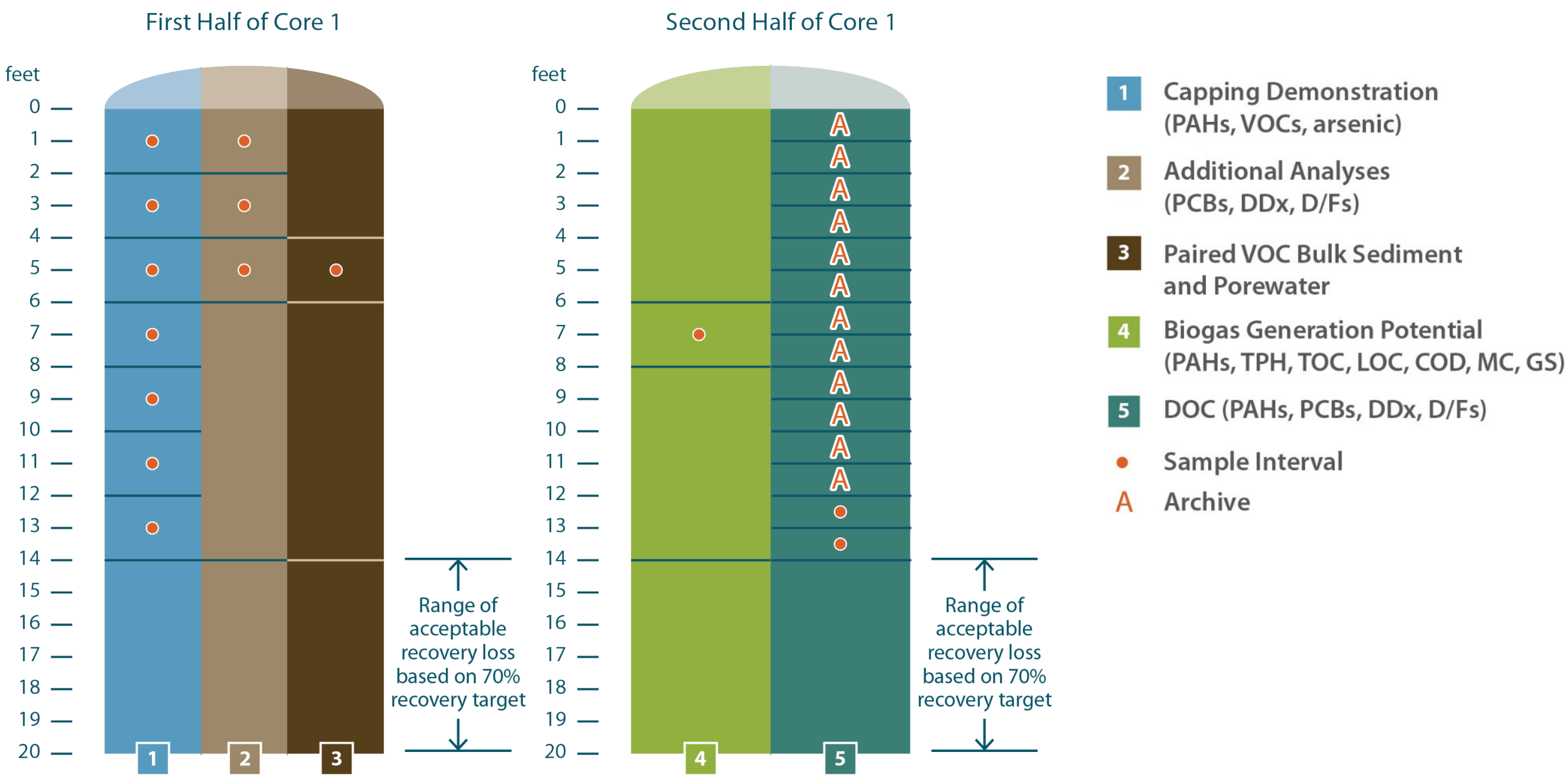
ANCHOR QEA

Figure 4
Proposed Subsurface Depth of Contamination and PTW-NAPL Boundary Refinement Cores
Pre-Remedial Design Data Gaps Work Plan
Gasco Sediments Cleanup Action

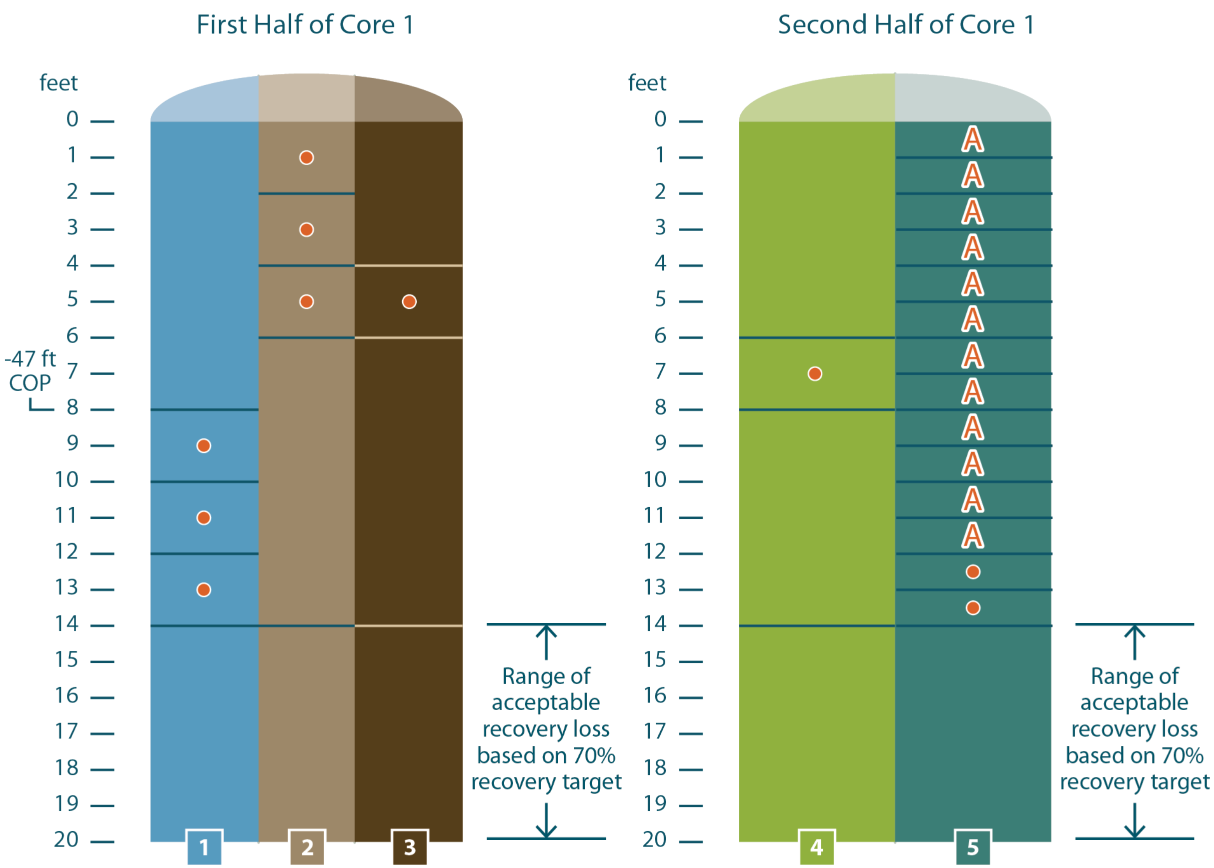
Core Processing: Nearshore Transect Outside of Navigation Channel (Shallow Region)



Core Processing: Offshore Transect Outside of Navigation Channel (Intermediate Region)



Core Processing: Inside Navigation Channel



1 Capping Demonstration (PAHs, VOCs, arsenic)

2 Additional Analyses (PCBs, DDx, D/Fs)

3 Paired VOC Bulk Sediment and Porewater

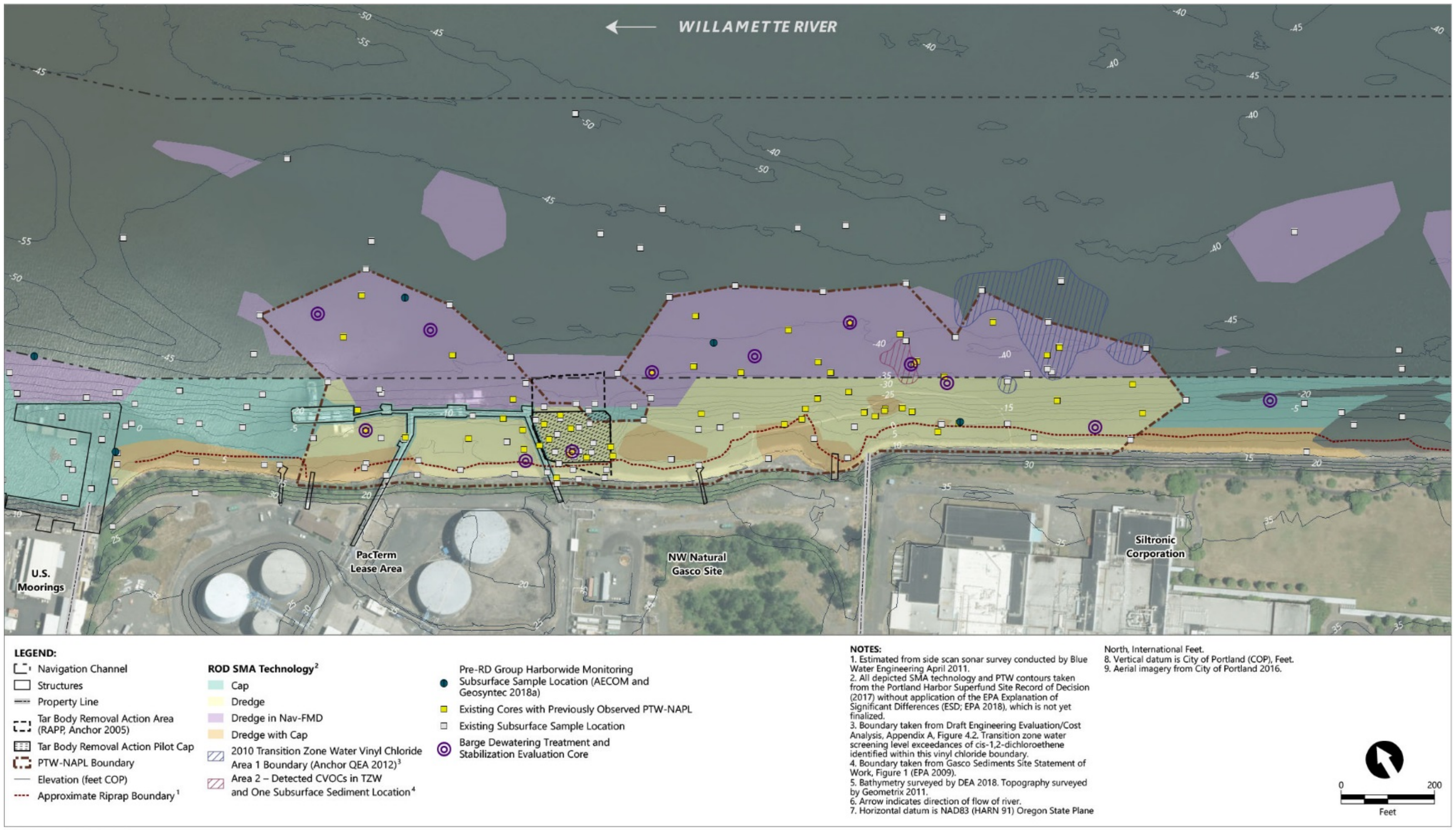
4 Biogas Generation Potential (PAHs, TPH, TOC, LOC, COD, MC, GS)

5 DOC (PAHs, PCBs, DDx, D/Fs)

● Sample Interval

A Archive

Barge Dewatering and Dredge Material Stabilization Sample Locations



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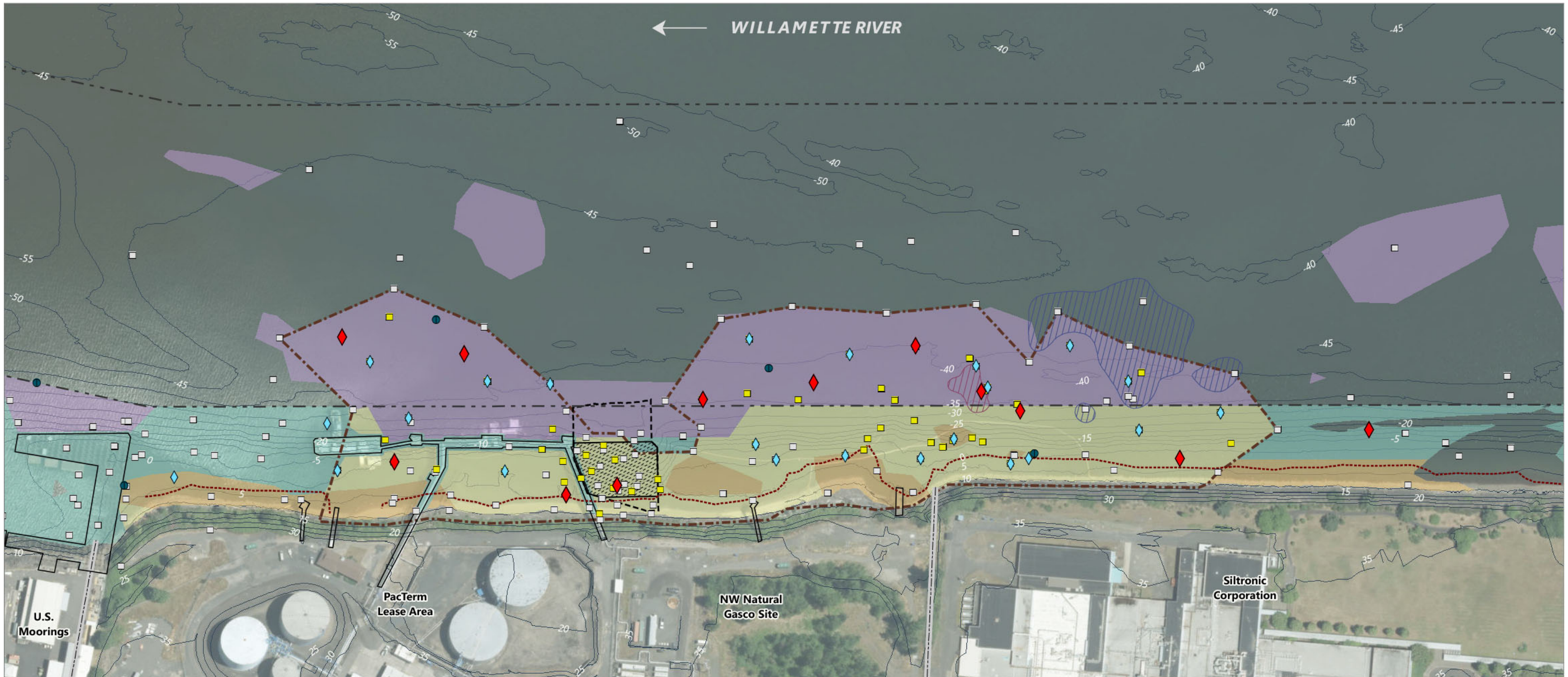
ANCHOR QEA

Figure 11
Proposed Dredge Material Barge Dewatering Treatment and Stabilization Evaluation Cores
Pre-Remedial Design Data Gaps Work Plan
Gasco Sediments Cleanup Action

Disposal Suitability Sample Locations



LEGEND:

- Navigation Channel
- Structures
- Property Line
- Tar Body Removal Action Area (RAPP, Anchor 2005)
- Tar Body Removal Action Pilot Cap
- PTW-NAPL Boundary
- Elevation (feet COP)
- Approximate Riprap Boundary[1]

ROD SMA Technology[2]

- Cap
- Dredge
- Dredge in Nav-FMD
- Dredge with Cap
- 2010 Transition Zone Water Vinyl Chloride Area 1 Boundary (Anchor QEA 2012)[3]
- Area 2 – Detected CVOCs in TZW and One Subsurface Sediment Location[4]

- Pre-RD Group Harborwide Monitoring Subsurface Sample Location (AECOM and Geosyntec 2018a)
- Existing Cores with Previously Observed PTW-NAPL
- Existing Subsurface Sample Location
- Existing TCLP Location
- Proposed TCLP/RBC Location

NOTES:

1. Estimated from side scan sonar survey conducted by Blue Water Engineering April 2011.
2. All depicted SMA technology and PTW contours taken from the Portland Harbor Superfund Site Record of Decision (2017) without application of the EPA Explanation of Significant Differences (ESD; EPA 2018), which is not yet finalized.
3. Boundary taken from Draft Engineering Evaluation/Cost Analysis, Appendix A, Figure 4.2. Transition zone water screening level exceedances of cis-1,2-dichloroethene identified within this vinyl chloride boundary.
4. Boundary taken from Gasco Sediments Site Statement of Work, Figure 1 (EPA 2009).
5. Bathymetry surveyed by DEA 2018. Topography surveyed by Geometrix 2011.
6. Arrow indicates direction of flow of river.
7. Horizontal datum is NAD83 (HARN 91) Oregon State Plane North, International Feet.
8. Vertical datum is City of Portland (COP), Feet.
9. Aerial imagery from City of Portland 2016.

TCLP: toxicity characteristic leaching procedure
RBC: risk-based concentration

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Feet

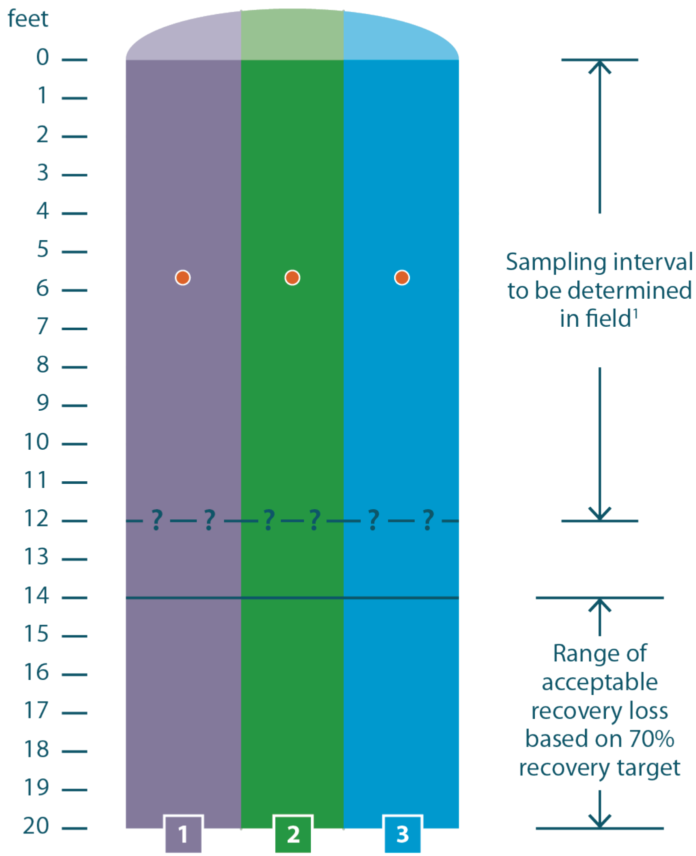
Publish Date: 2019/07/01, 3:36 PM | User: eiverson
Filepath: \\orcas\GIS\Jobs\NW_Natural_Gas_0029\Gasco_Sediments\Maps\Reports\DataGapsWorkPlan2018\AQ_DGWP_Fig12_SubsurfaceWasteCharacterization.mxd

ANCHOR QEA

Figure 12
Proposed Dredge Material Waste Suitability Characterization Cores
Pre-Remedial Design Data Gaps Work Plan
Gasco Sediments Cleanup Action

Core Processing: All Locations

Core 2 – Co-located with Core 1



1 Barge Dewatering Testing (ROD Table 17 COCs with GW CULs)

2 Dredge Material Stabilization Testing (variety of amendment types and doseages)

3 Disposal Suitability Testing (ignitability, corrosivity, F002 wastes, TCLP analytes)

● Sample Interval

[1]Sampling interval to be determined in the field based on visual and olfactory indications of contamination

PTW-NAPL Mobility Testing

- A third core, collected from up to 6 locations co-located with Core 1, will be shipped to the lab for PTW-NAPL mobility testing
  - These cores will be cut into manageable sections and sealed to facilitate shipment
  - These cores will not be opened prior to shipping
- The Core 3 locations will be determined in the field based on core intervals containing the most notable PTW-NAPL observations in Core 1

Other Sampling Activities

- Surface sediment grab samples (8 total locations)
  - 3-point composite grabs from 0 to 1 feet (4 locations)
    - Chemical analyses for COCs with ROD Table 21 COCs with RALs and PTW-highly toxic thresholds
  - Discrete grabs from 0 to 1 feet in depositional pilot cap area (4 locations)
    - Chemical analyses for COCs with ROD Table 21 COCs with RALs and PTW-highly toxic thresholds and ROD Table 17 riverbank/sediment CULs

Other Sampling Activities (cont.)

- Geotechnical explorations (26 total locations)
  - Standard penetration test using sonic boring (17 locations)
  - Cone penetrometer tests using in situ penetration (9 locations)
- Riverbank borings (8 locations)
  - Angled sonic borings
  - Chemical analyses for COCs with ROD Table 17 riverbank/sediment CULs; PAHs and VOCs with a ROD Table 17 groundwater CUL, and arsenic; and COCs with ROD Table 21 RALs and PTW-highly toxic thresholds

Other Sampling Activities (cont.)

- Subsurface porewater sampling in contact with PTW-NAPL
  - Up to 5 locations with variable sample intervals to be determined in the field based on visual observations of PTW-NAPL during logging of the DOC cores
  - Samples collected using a Geoprobe outfitted with a 2-foot screen advanced to the sample interval
  - Chemical analyses for PAHs and those VOCs with a ROD Table 17 groundwater CUL
- Ebullition visual survey with opportunistic sheen net chemical analyses
  - Chemical sampling areas to be determined following ebullition reconnaissance survey
  - Chemical analyses for TPH

Appendix K
Memoranda Regarding: “NW Natural Response to EPA Comments on Work Plan” and “NW Natural Response to EPA Conditional Approval Letter on the Gasco Sediments Site TEWP, DGWP, and Capping Approach”

Appendix K-1
NW Natural Response to EPA Comments on Work Plan

6720 SW Macadam Avenue, Suite 125
Portland, Oregon 97219
503.670.1108

ANCHOR QEA

Memorandum

August 22, 2019

To: Sean Sheldrake and Karl Gustavson, U.S. Environmental Protection Agency

From: Ryan Barth, PE, Anchor QEA, LLC

cc: Bob Wyatt, NW Natural
Patty Dost, Pearl Legal Group
Lance Peterson, CDM Smith
Dana Bayuk, Oregon Department of Environmental Quality
Paul Schroeder, U.S. Army Corps of Engineers
Myron Burr, Siltronic Corporation
Michael Murray, Maul Foster & Alongi

Re: NW Natural Response to EPA Comments on the Pre-Remedial Design Data Gaps Work Plan – Gasco Sediments Site

NW Natural submitted the *Pre-Remedial Design Data Gaps Work Plan* (DGWP) to the U.S. Environmental Protection Agency (EPA) on June 10, 2019. EPA provided comments to NW Natural in a letter dated August 12, 2019 (Attachment A). This memorandum serves as NW Natural's responses to EPA's comments based on numerous collaborative discussions with EPA.[1]

General DGWP Comments

EPA General Comment 1

NW Natural's Final Revised Pre-Remedial Basis of Design Technical Evaluations Work Plan (TEWP) is dated June 10, 2019 and it is yet to be approved by EPA. Any EPA comments on the TEWP that affect the scope outlined in this Work Plan need to be addressed and incorporated, as necessary. The DGWP is interconnected with the TEWP and the Summary of Final Cap Monitoring Approach – Gasco Sediments Site dated June 25, 2019 (to be incorporated into the TEWP). All three documents need to be cross-checked with each other to provide consistency and protectiveness in remedy design.

NW Natural Response

NW Natural has ensured that any revisions necessary to the TEWP and DGWP based on EPA comments will be cross-checked and made consistent across both documents. For this reason, both documents must be approved by EPA before the data gaps sampling can commence.

[1] For EPA's ease of reference, Anchor QEA's responses to EPA comments on its *Pre-Remedial Design Data Gaps Health and Safety Plan* (Appendix C) are consolidated in this letter.

EPA General Comment 2

The DGWP does not provide sufficient information to evaluate the appropriateness of the proposed sampling scope. Examples include the following:

a. There are several sections in the DGWP which indicate that proposed sample locations have been determined based on previous data interpretations that are not provided in the work plan (e.g. Section 3.2.3.1 discusses geotechnical locations based on existing cross sections).
b. Section 3.4 of the TEWP indicates the DGWP will present any data gaps identified during review of the Pre-RD Group sampling results. The status of reviewing Pre-RD Group sampling results, and integrating data gaps identified based on this data into the DGWP, is not clear.
c. Previous approved data collection and analytical approaches are not referenced and not being utilized in all cases for data gaps sampling (e.g., GeoProbe porewater sampling methods, core preservation).

The Basis of Design Report (BODR) must present a comprehensive summary of existing data with supporting visuals in the context of the refined dredging and capping areas to evaluate whether additional data gaps remain.

NW Natural Response

NW Natural has provided additional information in this response-to-comments memorandum and the DGWP regarding information relied upon to support development of the data gaps sampling scope of work. The Pre-RD Group collected four cores within the Interim Project Area, and none of these cores contained a bottom sampling interval containing sediment concentrations below the Record of Decision (ROD) Table 21 remedial action levels (RALs). Three of these cores are located within the principal threat waste-nonaqueous phase liquid (PTW-NAPL) boundary in the Interim Project Area. Therefore, NW Natural has proposed the collection of three cores co-located with the Pre-RD Group locations to attempt to identify the bottom depth of contamination using the methodologies presented in Section 3.4 of the DGWP. The fourth core is located in the Shallow Region and did not contain PTW-NAPL, so the bottom depth of contamination is not needed to support remedial design, as described in ROD Section 14.2.4.

The BODR will present a comprehensive summary of existing data with supporting visuals in the context of the refined dredging and capping areas to evaluate whether additional data gaps remain.

EPA General Comment 3

The ROD Table 17 cleanup levels are identified as the long-term contaminant targets to be achieved by the remedy to meet RAOs. EPA's May 29, 2019 e-mail informs NW Natural that Section 8.2.5 of the ROD requires post-construction verification that additional contaminants of concern (COCs) listed in Table 16 (i.e., "ROD-identified COCs posing potentially unacceptable risk") are addressed by the remedy. EPA recommends that NW Natural evaluate additional COCs during design. NW Natural's May 31, 2019 email response to Sean Sheldrake at EPA indicates that the pre-design data gaps investigations will collect the data necessary to design a remedy consistent with the ROD. The DGWP does not mention additional COCs or Section 8.2.5 of the ROD. Provide clarification regarding the activities NW Natural is undertaking, if any, during data gaps investigations to support evaluations of additional COCs during design. This also applies to text in Section 3.6 of the DGWP.

NW Natural Response

NW Natural supports the analysis and conclusions in the ROD for these potential COCs. The ROD's robust analysis used the results of the human health and ecological risk assessments to identify the list of COCs to be used to identify areas requiring active remediation to achieve the site-wide remedial action objectives. This analysis accounted for the magnitude of risks associated with each COC and the locations of these risks relative to the other risk driver COCs. The results of this analysis identified the focused risk driver COCs and associated action levels to be the RALs and PTW-highly toxic thresholds identified in ROD Table 21 and the cleanup levels identified in Table 17. NW Natural agrees with EPA's risk management decisions reflected in these ROD findings and has specifically designed the pre-remedial design data gaps investigation to obtain the data necessary to design a remedy using the cleanup levels that EPA has determined will be protective of all chemicals posing potentially unacceptable risk in ROD Table 16.

Consistent with the ROD Figure 28 technology application and decision tree and ROD Section 14 summary of the selected remedy, NW Natural will identify remedial technology assignments based on exceedances of the ROD Table 21 RALs and PTW-highly toxic thresholds, and the ROD Table 17 cleanup levels. The ROD does not include a remedy decision-making framework for the ROD Table 16 COCs that EPA determined did not warrant either RALs or cleanup levels, so NW Natural is not performing any data gaps sampling relative to those COCs. It is also important to note that the post-cleanup footprint within the Project Area will either be covered with a minimum 1.5 feet of clean residual management cover in all dredge and cover areas or several feet of clean cap sand and armor material in all capping areas. Therefore, the post-construction surface throughout the Project Area will contain concentrations equal to the clean material quarry concentrations below concentrations containing risk. NW Natural looks forward to working with EPA to complete the post-remedial action verification contemplated by ROD Section 8.2.5 to confirm that the remedial strategy EPA selected in the ROD is also protective of risks of lower ecological significance.

EPA General Comment 4

Revise the text to clearly state that if any data gaps associated with the evaluations outlined in the Final TEWP are identified, NW Natural will be required to address those data needs with additional pre-design investigation. Examples of potential data gaps include, but are not limited to, the following:

a. If it is determined that the remedy design is not appropriately protective of ROD Table 17 COCs and "ROD-identified COCs posing potentially unacceptable risk".
b. If co-located porewater (total and dissolved concentrations) and sediment samples are not collected and analyzed for the suite of analyses identified for the Spring 2018 porewater/sediment sampling event, including aluminum, barium, iron, magnesium, VPH, and EPH (with dissolved organic carbon for porewater samples). See specific comment 15.
c. If the entire list of 17 PAHs listed in QAPP tables is not analyzed in all data gap samples.

NW Natural Response

Section 3.0 in the DGWP has been revised to state that additional pre-remedial design investigation activities may be necessary if data gaps are identified following the completion of the sampling activities in the DGWP that prevent completion of the technical evaluations presented in the EPA-approved TEWP. As discussed in response to EPA General Comment 2, the pre-remedial design data gaps investigation is designed to obtain the data necessary to fill the data gaps identified in the TEWP and design a remedy using the subset of governing risk driver COCs. Please see our response to EPA General Comment 3 for our response regarding ROD Table 16. NW Natural acknowledges that the entire list of 17 polycyclic aromatic hydrocarbons (PAHs) listed in the Quality Assurance Project Plan (QAPP) tables is required to achieve the DGWP data quality objectives.

EPA General Comment 5

EPA requires both surface and subsurface remedial action level (RAL) or principal threat waste (PTW) exceedances to be evaluated for sediment management area (SMA) delineation. The DGWP does not appropriately acknowledge that subsurface data will be used to refine the project area boundary. EPA's remedial design principles provided as a follow-up to the March 20-21, 2019 workshops should be reviewed for further guidance. Specific comments on DGWP Sections 3.1.1, 3.1.1.2, 3.1.2, Appendix A Section 3.2.1, and the July 3, 2019 addendum discuss specific changes required to address this topic.

NW Natural Response

See responses to EPA Specific Comments 7 and 9.

EPA General Comment 6

The DGWP focuses on mobile nonaqueous phase liquid (NAPL) based on the site-specific definition of PTW-NAPL. Confirm or clarify whether figures depicting PTW-NAPL occurrence utilize the site-specific PTW-NAPL definition. The Gasco Statement of Work (SOW) states that "substantial product" will be addressed at the site which includes tar or potentially immobile product in addition to mobile NAPL. Provide clarification on how NW Natural's data gaps sampling and subsequent evaluations will incorporate non-mobile substantial product per the ROD, if encountered in the field.

NW Natural Response

The TEWP and DGWP figures use the PTW-NAPL footprint within the Interim Project Area identified in the ROD, which is consistent with the "liquid substantial product" footprint identified in the *Draft Engineering Evaluation/Cost Analysis [EE/CA] – Gasco Sediments Cleanup Site* (May 2012) using the site-specific mobile substantial product definition (i.e., "oozes" or "drips" out of the core during core observations). Any tar or potentially immobile product encountered that does not achieve the site-specific definition of PTW-NAPL will be addressed consistent with the ROD by comparing the bulk sediment concentrations to the ROD Table 21 RALs and PTW-highly toxic thresholds for total polycyclic aromatic hydrocarbons (TPAHs). All forms of PTW-NAPL discussed in the ROD will be addressed during remedial design consistent with the ROD's Technology Application Decision Tree.

EPA General Comment 7

Throughout the DGWP, NW Natural indicates that site-specific principal threat waste – not reliably contained (PTW-NRC) thresholds will be developed for Gasco and implies that EPA has agreed to this approach. This is a mischaracterization of the discussions between EPA and NW Natural that took place on April 4, 2019. Correct the DGWP to indicate that this discussion about PTW-NRC took place but that EPA did not specifically agree to the approach of developing PTW-NRC thresholds. Ultimately, EPA is willing to review NW Natural's proposed approach for determining site-specific PTW-NRC thresholds, and will determine upon that review if the approach is appropriate and acceptable.

NW Natural Response

Multiple sections in the DGWP have been revised to state that, consistent with the discussions on April 4, 2019, NW Natural will develop for EPA's review and approval site-specific PTW-NRC thresholds, if any, in the BODR via the capping demonstration evaluation described in Section 4.1 of the TEWP. The assumptions behind the Feasibility Study-level PTW-NRC thresholds identified in ROD Tables 7 or 21 are not consistent with site-specific conditions at the Gasco Sediments Site, and NW Natural believes the capping demonstration will generate more relevant design criteria.

EPA General Comment 8

The DGWP does not clearly indicate whether the capping demonstration and dredging evaluation will be performed throughout the project area, or limited to the areas designated in the Portland Harbor Record of Decision (ROD) for capping or dredging. For example, the proposed data gaps sampling program identifies capping only cores in ROD-identified cap areas, suggesting that a dredging evaluation will not be performed in these areas. The ROD requires that NAPL or PTW that cannot be reliably contained will be dredged unless it is present below the feasible depth limit of excavation technology so capping such areas in lieu of dredging will not be acceptable. Revise the DGWP to incorporate the following:

a. Document the underlying assumptions built into the data gaps scope of work and fully discuss the data collection objectives in terms of the remedial technologies and the areas being considered for the capping demonstration and/or dredging evaluation.

   NW Natural Response

   Section 3.0 has been revised to clarify that the sampling objectives and design in the DGWP were developed to facilitate completion of the capping demonstration and dredging evaluations throughout the Interim Project Area and specifically address the remedial technology flexibilities and limitations identified in the ROD.

b. Revise the dredging evaluation to detail how the limit of excavation will be determined in design.

   NW Natural Response

   Determination of the limit of excavation is discussed in Section 4.2 of the TEWP and will be fully detailed in the BODR. The proposed data gaps sampling scope allows for the determination of the depth of contamination (DOC) throughout those portions of the Interim Project Area that currently contain or may be shown to contain PTW that cannot be reliably contained based on site-specific capping demonstrations to be reviewed and approved by EPA. For this reason, both documents must be approved before data gaps sampling can commence.

c. Acknowledge the scenario where dredging is required before capping in areas where PTW-NAPL extends beyond the feasible depth limit of excavation technology and discuss how an appropriate dredge depth is going to be determined.

   NW Natural Response

   Section 3.0 has been revised to acknowledge a scenario where dredging is required before capping in areas where PTW-NAPL that cannot be reliably contained extends beyond the feasible depth limit of excavation technology.

EPA General Comment 9

EPA's River Bank Guide needs to be consulted once it is finalized. In addition to evaluating exceedance(s) of RAL and PTW-highly toxic thresholds for riverbank remediation, areas of erodible or non-erodible river banks with contaminant concentrations in soil/sediment greater than cleanup levels (CULs) but less than sitewide RALs may need an action which would be determined through a risk-based decision process. Future design documents should include detailed evaluations identifying riverbanks requiring active remediation.

NW Natural Response

Once EPA's Final River Bank Guide is available, NW Natural will consult the guide to support completion of the riverbank remedy evaluations in the BODR. Section 3.3.1 of the DGWP has been revised to state that exceedances of the ROD Table 17 riverbank soil/sediment CULs will be used to inform the riverbank remedy evaluations. However, as stated in Section 4.3 of the TEWP, due to the steep riverbank slope adjacent to the Gasco property, the entire riverbank in this area will automatically be reconfigured (excavated and regraded) to achieve a shallower slope and then capped.

EPA General Comment 10

Samples from sediment cores will be selected for analysis to meet a variety of data collection objectives. Perform an assessment of the volumetric material requirements from cores to document adequate sample volume in a core to achieve all of the objectives identified in the DGWP. Include any limitations on NW Natural's ability to fully implement the scope of work for all sample types and analyses in the DGWP.

NW Natural Response

During development of the DGWP, NW Natural performed an assessment of the volumetric material requirements for all proposed cores to determine whether adequate sample volume is available in a core to achieve all of the objectives identified in the DGWP. Schematics of this assessment are summarized in the presentation *Summary of Core Processing Procedures – Gasco Sediments Site* prepared by Anchor QEA and submitted to EPA on July 22, 2019. This presentation has been added as Appendix J in the DGWP. There are no volume limitations on NW Natural's ability to fully implement the scope of work presented in the DGWP.

EPA General Comment 11

All field deviations from the EPA approved DGWP and Appendix A Field Sampling Plan (FSP) need to be reported for EPA approval as soon as possible and recorded on field deviation forms.

NW Natural Response

NW Natural will report as soon as possible all field deviations from the EPA-approved DGWP and associated appendices for EPA approval and record them on field deviation forms.

EPA General Comment 12

Easement authorization from the Department of State Lands (DSL) is discussed only in the context of capping. Revise the text to indicate that DSL will be consulted to determine applicable easement authorization for all remedial activities. The Basis of Design report should document the status and/or outcome of DSL consultations.

NW Natural Response

The text has been revised regarding the applicability of the DSL easement to the Interim Project Area. The BODR will document the status of the DSL consultations.

EPA General Comment 13

Clear and concise standard operating procedures (SOPs) should be provided for the field teams so that they can follow through a single task from start to finish. For example, field duplicates are first mentioned in section 3.11.1 of Appendix A but duplicates are not mentioned in the sections of the work plan or field sampling plan which discuss the number of samples or the sample collection process, so field teams collecting samples could inadvertently omit this step. A core processing SOP should clearly identify how cores will be cut for shipping while being held vertically, what is done to prevent sediment loss, and how cross-contamination from the saw will be mitigated.

NW Natural Response

The Anchor QEA field team will perform all sampling activities in accordance with the EPA-approved FSP and QAPP using detailed, stepwise SOPs. The SOPs will address the example issues referenced in the comment.

EPA General Comment 14

Lack of details and vagueness detracts from the usability of Appendix B – Quality Assurance Project Plan (QAPP). The QAPP is written generically and does not contain sufficient information to satisfy EPA's Guidance for QAPPs [*Footnote:* Guidance for Quality Assurance Project Plans, EPA QA/G-5, EPA/240/R-02/009, December 2002]. Sufficient detail is needed such that another party could implement the work as intended. Currently, the reader has no frame of reference for what gaps are being investigated, what media are being sampled, and what parameter groups will be analyzed. In addition, the reviewer cannot ascertain if the tables are complete since the media and analytical groups being investigated are unclear. There is some reference to the Work Plan and field sampling plan (FSP) but this causes a lot of searching for information which is not always easily found making the QAPP cumbersome to use. At a minimum, the following items are needed to improve the usability of the document.

a. In the Introduction add the regulatory framework for the investigation.

NW Natural Response

The requested revision has been made to the referenced section in the QAPP.

b. In the Introduction section add the problem statement, and project objectives.

NW Natural Response

The requested revision has been made to the referenced section in the QAPP.

c. Add a summary table showing analytes and media of interest/depth with rationale for collection and how the information obtained will be used to meet the project objectives. Reference this table in the Introduction.

NW Natural Response

A new Table 1b is referenced in Section 1 of the QAPP that provides the sampling program, analyses, and rationale/objective summary. The DGWP provides a detailed summary of how the sampling activities will achieve the project objectives for each media, and this information is too extensive to distill into a tabular format.

d. If this information is included in other Work Plan or FSP add a summary or copy for utility.

NW Natural Response

The requested revision has been made to the referenced section in the QAPP.

EPA General Comment 15

Method modifications are listed on several tests in Appendix B tables; add a note to the tables describing the modifications and explaining the rationale for their usage.

NW Natural Response

The requested notes were added to the QAPP tables.

Specific DGWP Comments

EPA Specific Comment 1

Section 2.1.2 Element 3 – Erosion Resistance, Pages 3-5. Note that caps will also be designed to withstand erosion associated with more frequent floods with higher peak flows more common with climate change, as stated in Record of Decision (ROD) Section 14.2.9.1. Revise the text to discuss that the impact of climate change on stage and river flow will be included in the cap design. Revise the text to include a provision for refinement of the Environmental Fluid Dynamics Code hydrodynamic model grid resolution in the vicinity of the project area, if needed after review of the integrated multibeam bathymetry and light detection and ranging (LiDAR) survey collected in April 2019. The model grid should aim to reproduce key morphological features as apparent in the bathymetry and which can have an impact on the spatial and temporal distribution of currents and water depths (both of which are inputs to the design formulation for the erosion protection layer). In areas to be capped the bathymetry should reflect the post-cap condition for the purposes of cap erosion. Also include references to the design guidance document(s) to be used for the design of the erosion protection layer for river currents, propeller wash, and vessel-generated waves.

NW Natural Response

The text in the referenced section of the DGWP has been revised to discuss climate change. The text has been revised to discuss the refinement of the Environmental Fluid Dynamics Code hydrodynamic model grid resolution in the vicinity of the Interim Project Area, if needed, based on a review of the bathymetry survey. The requested references for the design of the erosion protection layer of the cap are detailed in Section 4.1.5 of the TEWP. No revisions were made to the DGWP based on this portion of the comment.

EPA Specific Comment 2

Section 2.1.3 Element 4 – Presence and Effect of Debris, Page 5. Revise the list of information to include debris orientation. Based on the TEWP, low-profile debris with length and width much larger than height dimension may be left in place so in addition to dimensional size, the orientation is also important.

NW Natural Response

The requested revision has been made to the referenced section in the DGWP.

EPA Specific Comment 3

Section 2.1.4 Element 7 – Treatment Requirements, Page 5. Revise this section to include discussion of how sorption characteristics of the amendment being used will be determined e.g. using sorption characteristics from product vendors, available literature, site-specific sorption testing, etc. Text in Section 2.1 states that: "The data gaps will be addressed using existing publicly available information." NW Natural should note that certain proprietary or at least not explicitly publicly available information would be needed to consider treatment requirements. NW Natural should note that the use of treatment amendments can enhance the performance of less thick caps. The evaluations of capping elements should allow necessary flexibility to improve remedy design, including considering and incorporating treatment options.

NW Natural Response

The requested revision has been made to the referenced section in the DGWP. Remainder of comment noted.

EPA Specific Comment 4

Section 2.2 Functional Structures Determination, Page 6. EPA recommends reviewing the methods described in EPA's January 24, 2014 letter titled *Response to Proposed Methods for the Substantial Product Accessibility Analysis, Gasco Sediments Site* in conjunction with the ROD requirements for functional structures.

NW Natural Response

NW Natural will review the referenced letter to support the functional structures determination required by the ROD.

EPA Specific Comment 5

Section 2.5 Bathymetry and Topography Survey, Page 7. The last paragraph states that: "The topography in the direct vicinity of the riverbank has not changed substantially since these survey dates, so NW Natural does not propose an updated survey landside of the top of the riverbank." Include language documenting what information was relied on to determine that the topography in the direct vicinity of the riverbank has not changed substantially since the 2006 and 2011 topographic surveys.

NW Natural Response

The requested revision has been made to the referenced section in the DGWP.

EPA Specific Comment 6

Section 3 Data Gaps Sampling and Analysis, Page 9. The text states that: "EPA has indicated that the work can proceed with no additional permitting and that the work can occur outside the generally approved in-water work window of July 1 to October 31, provided that standard best management practices are implemented to avoid adverse effects to fish and wildlife and the aquatic environment." While EPA agrees, include a citation for the discussions being referenced.

NW Natural Response

This text is based on an email from Sean Sheldrake dated January 12, 2018. This citation has been added to the referenced section in the DGWP.

EPA Specific Comment 7

Section 3.1 Interim Project Area Refinement Evaluation, Pages 9-10. EPA comments on this section are as follows:

a. Section 3.1 text acknowledges that refinement of the Interim Project Area may be necessary based on the results of surface and subsurface sediment data gaps sampling data. Provide additional clarification regarding data use for project area boundary changes, and acknowledge that additional data collection may be warranted depending on changes to boundaries and implications for technology assignments.

NW Natural Response

Sections 3.0 and 3.1 have been revised to provide additional clarification regarding data use for Interim Project Area boundary refinements and acknowledge that additional pre-remedial design investigation activities may be necessary if data gaps remain following the completion of the sampling activities in this DGWP.

b. As stated in the general comment regarding substantial product, revise text in this section to provide clarification on how NW Natural's data gaps sampling and subsequent evaluations will address all substantial product as defined in the SOW. Clarify if the DGWP figures show a PTW- NAPL boundary or if this includes all substantial product. Include a framework for identifying and evaluating non-mobile product or tar observed in samples and its ability to be mobilized.

NW Natural Response

See response to EPA General Comment 6. Section 3.1.1 of the DGWP details how the data gaps sampling approach evaluates visual, mobile PTW-NAPL and immobile PAH-impacted materials via bulk sediment concentrations to the ROD Table 21 RALs and PTW-highly toxic thresholds. No text revisions have been made to the DGWP based on this comment.

c. The PTW-NAPL boundary is defined by the "outer perimeter of the subsurface sampling locations that contain no PTW-NAPL through the complete sampled depth." Provide information on clean core depths for cores used to delineate PTW-NAPL.

NW Natural Response

The recovery depths for outer perimeter PTW-NAPL cores are presented in Attachment B.

d. The text states that PTW-highly toxic areas will be identified based on surface sediment data. As discussed during the March 21-22, 2019 EPA workshops, if there is exceedance of PTW-highly toxic thresholds for subsurface sediment then appropriate evaluations will be needed to verify that there is no potential for future exposure to the highly toxic PTW material.

Whether or not these areas will be included in an SMA is dependent on the chemical and physical stability of the buried material.

NW Natural Response

Section 3.1.1 has been revised to identify that subsurface sediment data will be screened against the PTW-highly toxic thresholds and appropriate evaluations will be performed to verify whether there is a potential for future exposure to the PTW-highly toxic material. In addition, Figure E-2 in the newly added Appendix E to the DGWP depicts the surface and subsurface PTW-highly toxic threshold exceedances surrounding the perimeter of the Interim Project Area. Figures 3a and 3b depict the net bathymetry changes between multiple surveys completed within the Interim Project Area between 2003 and 2018 to support evaluations of potential for future exposure.

e. The ROD RALs bullet point states that surface sediment concentrations will be compared against the focused COC RALs. As indicated during the EPA March 20-21, 2019 workshops, surface and subsurface exceedances of RALs are to be used for sediment management area (SMA) delineation. Include discussion comparing subsurface RAL exceedances with the project area boundaries.

NW Natural Response

Section 3.1.1 has been revised to identify that subsurface sediment data will be screened against the RALs and appropriate evaluations will be performed to verify whether there is a potential for future exposure to the RAL exceedances. Section 3.1.1.2 has been revised to summarize subsurface sediment RAL exceedances along the perimeter of the Project Area. Figure E-1 in the newly added Appendix E has been added to depict the surface and subsurface RAL exceedances surrounding the perimeter of the Interim Project Area. Figures 3a and 3b depict the net bathymetry changes between multiple surveys completed within the Interim Project Area between 2003 and 2018 to support evaluations of potential for future exposure.

EPA Specific Comment 8

Section 3.1.1.1.4 Data Density, Page 11. In order to maintain the data density described in this section and to appropriately refine the project area, at least one additional proposed three-point composite surface sediment sample and one additional sediment core needs to be added in the downriver channelward area outside the current project area boundary shown in Figure 3. Figures 3 and 4 do not show any existing sediment results or proposed samples for this corner.

NW Natural Response

Sections 3.1.1.1.4 and 3.1.1.2, respectively, have been revised to include the collection of a single additional three-point composite sediment grab and co-located subsurface sediment core in the referenced area. This additional three-point composite grab is identified on revised Figure 3, and the core is identified on revised Figure 13 in the DGWP.

EPA Specific Comment 9

Section 3.1.1.2 Subsurface Sediment Cores, Page 12. Add a figure comparing subsurface RAL exceedances with project area boundaries and include an assessment of whether the subsurface data available is sufficient for delineating project area boundaries.

NW Natural Response

Figures E-1 and E-2 in the newly inserted Appendix E of the DGWP present figures showing the subsurface sediment ROD Table 21 RAL and PTW-highly toxic threshold exceedances, respectively. Section 3.1.1.2 includes an assessment of whether the subsurface data available is sufficient for delineating the Interim Project Area boundaries.

EPA Specific Comment 10

Section 3.1.2 Interim Project Area Refinement Evaluation Data Collection Methods, Subsurface Cores, Page 12. The text states that: "No chemical analyses will be performed on these cores for the purposes of Interim Project Area refinement." As discussed at the EPA March 20-21, 2019 workshops, both surface and subsurface data is to be used for SMA delineation, so the subsurface cores should be used for project area refinement. The second bullet point proposes a core recovery acceptability criterion of 70%, based on a review of core recoveries from the Interim Project Area. Provide additional detail to clarify how historical core recoveries were used to inform this criterion. The recovery criterion should reflect best coring practices.

NW Natural Response

As shown in FSP Figure A-9, the percent recovery from each historical core of similar length to the proposed cores (i.e., 15 feet or greater) was reviewed to inform the 70% criterion. The average recovery of the cores is 69% with a standard deviation of 16%. Of the 38 cores analyzed, 8 had recoveries greater than 80%, 16 had recoveries between 70% and 80%, and 14 had recoveries below 70%. NW Natural believes using a 70% criterion is appropriate given the existing data to balance the amount of time attempting to achieve the target core recovery depth at each station and managing associated investigation derived waste for core material that does not achieve the target and is discarded. As discussed in Section 3.4.1 of the DGWP, NW Natural agrees to consider the collection of deeper cores using a different drilling technology in a subsequent phase of work if the DOC remains unbounded in some areas and deeper data is necessary to support the remedial design evaluations identified in the TEWP or limited subsurface sediment chemical inventory assessments required by EPA. No revisions were made to the DGWP based on this comment.

EPA Specific Comment 11

Section 3.2 Capping Demonstration Evaluation, Page 13. Note that the Summary of Final Cap Monitoring Approach – Gasco Sediments Site dated June 25, 2019 developed in coordination with EPA is expected to be implemented, when finalized.

NW Natural Response

This approach will be utilized in the BODR, once approved by EPA. For this reason, both the Final Cap Monitoring Approach and DGWP must be approved before data gaps sampling can commence.

EPA Specific Comment 12

Section 3.2 Capping Demonstration Evaluation, NAPL Reactive Layer, Page 14. In addition to the three PTW-NAPL transport mechanisms (i.e., advection, gas ebullition-facilitated transport, and sediment consolidation), NW Natural should acknowledge and account for NAPL mobilization during dredging (NAPL flow out of the cut-face) during planning and design. EPA recommends that a range of PTW-NAPL samples be evaluated as part of the advection analysis, including samples exhibiting sheen. Sheen can be a source of contamination at concentrations that warrant consideration for chemical containment during cap design. EPA recommends that samples of water with sheen be collected for analysis across the project area.

NW Natural Response

The BODR will account for potential NAPL mobility during dredging. The range of NAPL mobility cores discussed in Section 3.2.2 of the DGWP will be revised to include one core that includes notable sheen but is not PTW-NAPL. Sheen net samples will be collected as discussed in Section 3.2.2.1.2 to characterize chemical mass flux associated with sheens that would require mitigation during cap implementation. There are no identified uses of analytical data for water samples containing sheen as part of remedial design; therefore, none are proposed.

EPA Specific Comment 13

Section 3.2.1.1.1 Porewater Concentrations Calculated from Bulk Sediment, Page 14. EPA comments on this section are as follows:

a. The sampling approach indicates samples within the navigation channel will be collected from -47 feet COP and below. This information appears to assume that material above -47 feet COP will be removed. Confirm or clarify this assumption.

NW Natural Response

NW Natural confirms that surface and subsurface sediment concentrations that exceed the ROD Table 21 RALs and PTW-highly toxic thresholds in the navigation channel down to an elevation of -47 feet City of Portland Datum (COP) will be dredged and covered, consistent with the ROD Figure 28 technology application decision tree.

b. The DGWP proposes 2-foot core intervals throughout. Provide clarification regarding whether the resolution of the sampling is sufficient to develop a high-resolution dredge prism as required for the precision dredge methods described in the TEWP.

NW Natural Response

To clarify, the DGWP only proposes 2-foot composite core intervals in the navigation channel beneath -47 feet COP (elevation where capping becomes an applicable remedial technology, as described in Section 3.2.1.1.1 of the DGWP) and in the intermediate region to support capping demonstrations. As discussed in Section 3.4.2 of the DGWP, dredge prism delineation will be based on the stepwise characterization of two consecutive 1-foot intervals initiating at the bottom of the core and proceeding upwards to shallower elevations. The dredge prism will be based on the use of these 1-foot core intervals. It is important to note that 1-foot core intervals will be archived throughout each sampled core (pending volume availability) for potential future analysis to support refinement of the dredge prism, if/where necessary. For this reason, both the TEWP and DGWP must be approved before data gaps sampling can commence.

c. This section states that in the intermediate zone the "…pre-cap elevation is unknown and capping does not depend on the DOC results." Clarify if DOC will be preliminarily used for the dredging elevation and for the capping demonstration, and a representative sample interval will be used once the cap surface elevation is determined.

NW Natural Response

The DOC will be used for dredge and cover technology assignments; whereas, the 2-foot depth interval (navigation channel deeper than -47 feet COP and intermediate region) and 2- to 3-foot depths intervals in the shallow region will be used for the capping demonstrations. As discussed in Section 3.2.1.1.1, the sampling objective for chemical isolation modeling is to "measure bulk sediment concentrations approximately 4 feet below the pre-cap surface elevation, unless PTW-NAPL is identified at deeper depths, in which case deeper samples will be collected from the underlying PTW-NAPL depth interval(s)." The combined 1-foot depth interval proposed for the DOC sampling (coupled with archived 1-foot depth intervals throughout the full depth at each proposed core location) and 2- to 3-foot depth intervals proposed for capping demonstrations will provide sufficient data to allow for the application of dredging and capping at any elevation within the Interim Project Area.

d. Provide the rationale for selecting 10 to 13-feet as the last sampling interval, and terminating sampling at 13-feet.

NW Natural Response

NW Natural limited the bottom sampling depth of 10 to 13 feet only in the shallow region (unless PTW-NAPL is identified at deeper depths, in which case deeper samples will be collected from the underlying PTW-NAPL depth interval[s]) because ROD Section 14.2.4 and Figure 28 identifies that dredging in this region is only required down to 5 feet unless PTW-NAPL that cannot be reliably contained is present at deeper depths. Although the chemical isolation sampling objective is to measure bulk sediment concentrations approximately 4 feet below the pre-cap surface elevation (which would be 9 feet below mudline), NW Natural conservatively proposes the collection of samples to 13 feet in case dredging is required deeper than 5 feet due to engineering considerations (e.g., slope stability).

e. Confirm whether the method for collecting VOCs will be EPA Method 5035 and subsamples of sediment from each 2-foot interval will be placed in methanol.

NW Natural Response

NW Natural confirms these methods are correct.

f. Provide the rationale for using a 4-foot sampling depth for the cores being collected to measure bulk sediment concentrations.

NW Natural Response

No 4-foot sampling depths are proposed in the DGWP. See responses to EPA Specific Comments 14a through 14d and Appendix J of the DGWP.

EPA Specific Comment 14

Section 3.2.1.1.1 Porewater Concentrations Calculated from Bulk Sediment, Navigation Channel, Page 15. For transparency, provide the rationale behind the assumption of a 3-foot buffer depth for caps in the navigation channel.

NW Natural Response

The text has been revised to clarify why a 3-foot buffer depth (conservative upper end identified in Section 14 of the ROD) was assumed for caps in the navigation channel.

EPA Specific Comment 15

Section 3.2.1.1.2 Paired Bulk Subsurface Sediment and Co-Located Porewater Samples to Develop Site-Specific Equilibrium Partitioning Coefficients for VOCs, Page 17. The text states that: “The proposed locations are identified in areas containing a representative range of VOC bulk sediment and porewater concentrations.” Provide clarification for what is meant by representative. If lower concentrations will create problems in developing appropriate partition coefficient values there may be no benefit to sampling the lower VOC concentration areas. Also clarify the basis for using only three VOCs (benzene, trichloroethene (TCE), and vinyl chloride) to support the sampling scope and include information on how the depths for these samples were determined. Appendix E shows figures characterizing VOC concentrations in sediment at various depths. The text in this section states that: "Based on review of the existing subsurface VOC concentrations throughout the Interim Project Area, the paired samples will be collected from 4 to 6 feet below the mudline in the intermediate region and 5 to 7 feet below mudline in the shallow region." Provide clarification on how the review of the existing data was used, including additional information to clarify if the sample depths were selected to target the highest concentrations or some specific range of concentrations. Existing data should be provided in the Basis of Design Report, including the monitoring data for in-water installations. Relevant information should be summarized and discussed for context. For clarification, there are "ROD-identified COCs of lower risk" that are could have partitioning coefficients lower than literature values (e.g. carbon disulfide, isopropylbenzene), and could therefore be considerations for cap design.

In addition to VOCs, NW Natural should consider collecting and analyzing co-located porewater (total and dissolved concentrations) and sediment samples referenced in this section for the full suite of analyses identified for the Spring 2018 porewater/sediment sampling event, including aluminum, barium, iron, magnesium, VPH, and EPH (with dissolved organic carbon for porewater samples). These data were included in the objectives of the Spring 2018 sampling event but were apparently not collected due to sample volume issues. The Spring 2018 data feed into the evaluations presented in the TEWP that are the basis for the data gaps porewater/sediment sampling and analytical approach in the DGWP. If these data are identified as a data gap that is required to be completed for remedy design, NW Natural will have to address this as part of an additional pre-design investigation.

NW Natural Response

If analyte concentrations are similar at all locations, an equilibrium trend cannot be determined and, therefore, a site-specific equilibrium partitioning coefficient cannot be determined. NW Natural used the existing extensive subsurface bulk sediment volatile organic compound (VOC) data and limited subsurface porewater VOC data to identify a range of VOC concentrations that would allow development of sediment-porewater equilibrium partitioning curves. The depths were determined based on professional judgment by reviewing the various depth interpolations of existing data presented in Appendix F in the DGWP. In addition, the porewater depth intervals were selected to correspond with capping demonstration bulk sediment VOC sample intervals from co-located cores (sediment) and Geoprobe wells (porewater) so relationships can be determined without collecting additional bulk sediment data. To maximize the potential to collect samples with a range of VOC concentrations, the sample locations and depth intervals were selected so that a portion of samples are collected from areas with the highest measured existing concentrations and the remainder of samples are collected from lower-concentration areas. No revisions were made to the DGWP based on this comment.

EPA Specific Comment 16

Section 3.2.1.1.3 Subsurface Porewater Samples in Contact with PTW-NAPL Sediments, Pages 17-18. The first paragraph of this section discusses the use of porewater samples to define cap model input concentrations. Revise the text in this section to clarify that the dissolved porewater concentrations are to be addressed by these samples and the NAPL product advection is to be addressed separately as described in Section 3.2.2.

NW Natural Response

The text has been revised to clarify that the dissolved porewater concentrations are to be addressed by these samples and the NAPL product advection is to be addressed separately as described in Section 3.2.2.

EPA Specific Comment 17

Section 3.2.1.1.3 Subsurface Porewater Samples in Contact with PTW-NAPL Sediments, Page 18. The second paragraph of this section discusses a "representative range of PTW-NAPL characteristics" that will be identified to determine porewater sampling locations. List factors/characteristics that are expected to be evaluated in the field to determine representative sampling locations and discuss what is meant by representative. The text also states that "locations and collection depths will be determined in the field". Include text clarifying when and how this information will be communicated to EPA for approval.

NW Natural Response

The text has been revised to list the factors and characteristics that will be evaluated to determine sampling locations and collection depths, and how this information will be communicated to EPA for approval.

EPA Specific Comment 18

Section 3.2.1.2.1 Porewater Concentrations Calculated from Bulk Sediment, Page 18. The text indicates that VOC samples will be collected from sediment by immediately placing material into sampling jars using decontaminated bowls and spoons without homogenization. Section 3.4.3 of Appendix A indicates that to minimize volatilization, the sample collection method for VOCs will use a clean "t-bar" sampler to extract and place subsamples from the sampling interval into a pre-labeled container with methanol preservative prior to homogenization. The method described in Section 3.4.3 of Appendix A is the preferred method. Revise the text to confirm the use of this method for collecting all sediment samples for VOC analysis, and that references to EPA Method 5035 in the DGWP are referring to this sampling procedure.

NW Natural Response

The requested text revision has been made to the referenced section of the DGWP.

EPA Specific Comment 19

Section 3.2.1.2.2 Paired Bulk Subsurface Sediment and Co-Located Porewater Samples to Develop Site-Specific Equilibrium Partitioning Coefficients for VOCs, Page 19. EPA comments on this section are as follows:

a. The text states that: "if there is visual heterogeneity in sediment characteristics, the sample will be collected from the most visually impacted sediment within the sample interval." Discuss what is meant by "most visually impacted", for example, does this refer to potential visual evidence of product or NAPL impacts.

NW Natural Response

The text has been revised to discuss what is meant by "most visually impacted."

b. Provide rationale in the text for using a Geoprobe for porewater sampling and not the Trident probe technology used during the Spring 2018 porewater sampling event.

NW Natural Response

The proposed porewater samples will be collected from 4 to 6 feet and 5 to 7 feet below mudline. These sampling depths are much deeper than the transition zone water sampling performed from the 0- to 1-foot interval using a Trident probe during the 2018 sampling. No revisions were made to the DGWP based on this comment.

c. Co-located porewater/sediment samples should be collected as close as possible with a maximum offset of 20 feet which is consistent with the Spring 2018 co-located porewater/sediment sampling.

NW Natural Response

NW Natural acknowledges the 20-foot maximum offset distance and will coordinate with EPA if the situation arises where a greater distance offset is required at a location to achieve the sampling objectives.

d. Co-located porewater/sediment samples should be collected from 4 to 6 feet in the intermediate region and 5 to 7 feet in the shallow region, as stated in Section 3.2.1.1.2, and analyzed for all parameters.

NW Natural Response

This comment is consistent with the sampling depths and analytes described in the DGWP.

e. The length of the screen through which porewater samples will be collected is referenced as being 2-feet in length in this section, and 4-feet in length in Section 3.5.2 of Appendix A. Resolve this inconsistency.

NW Natural Response

Section 3.5.2 of Appendix A was revised to identify a 2-foot screen interval.

f. EPA recommends using a conductor casing with a platform (or plate) welded to one end to reduce the potential for surface water/porewater mixing.

NW Natural Response

The anticipated sampling depths are a minimum of 4 feet below the mudline so the potential for surface water/porewater mixing is minimal, especially considering the porewater sampling rate is less than 0.5 liters per minute. No changes were made to the DGWP.

g. Include a discussion on the potential for the ceramic filter to influence VOC results.

NW Natural Response

The ceramic material is inert, and the proposed porewater samples will be collected by actively pumping through the porous ceramic. Therefore, the ceramic filters will not adversely affect VOC results in porewater samples. The use of ceramic filters will also provide an important data quality benefit by avoiding entrainment of NAPL in porewater samples, which would lead to significant overestimation of dissolved COC concentrations.

Gefell et al. 2019[2] presented data from two field trials of groundwater sampling using porous ceramics. In both cases, VOC analytical results were benchmarked against other sampling methods. The first field trial was performed at a USEPA Region 1 Superfund Site with chlorinated solvents and BTEX in groundwater. Ceramic samplers were tested in three wells with historical DNAPL accumulation. VOC concentrations indicated a strong correlation (i.e. coefficient of determination of 0.99) between concentrations detected in the samples collected using ceramic samplers versus those in the benchmark samples collected using Hydrasleeve (non-filtered sampling method).

The second field trial was performed at a petroleum site in Colorado with BTEX compounds in groundwater. Groundwater was sampled by pumping through a ceramic filter as well as using standard low-flow sampling methods without filtering. The relative percent difference

[2] Gefell, M.J., D. Vlassopoulos, M. Kanamatsu, D.S. Lipson, and B.R. Thompson, 2019. Advancing Mobility Testing and Aqueous-Phase Sampling in NAPL Zones. RemTEC Summit (Denver), February 26-28, 2019.

between the detected BTEX concentrations using both methods were within typical acceptability range for laboratory analytical variability, as measured using matrix spikes and matrix spike duplicates. Provide clarification if the use of peristaltic pumps is appropriate for collecting shallow water samples.

NW Natural Response

Gefell et al. 2018[3] presented VOC and PAH analytical results for water samples collected with ceramic filters by passive diffusion (without pumping) and also by pumping using peristaltic pumps. The relative percent differences (RPDs) between the average PAH and VOC concentrations reported for the passive diffusion samples and the peristaltic pump samples were within the range that would be expected due to laboratory method variability. Therefore, we do not anticipate any adverse influence of using a peristaltic pump to collect porewater samples.

h. The representativeness of sediment VOC data increases with the number of subsamples collected from each 2-foot interval. EPA recommends that at least 2-subsamples (one from each foot of the sample interval) be collected from visually homogenous sediment consistent with EPA Method 5035.

NW Natural Response

All previous VOC sampling at the Gasco Sediments Site has included the collection of a single subsample within the target composite sampling depth. Therefore, NW Natural will maintain the currently proposed approach to achieve consistency with past sampling methods and associated data. No changes were made to the DGWP based on this comment.

i. This section indicates that if there is visual heterogeneity in sediment characteristics, the sample will be collected from the most visually impacted sediment within the sample interval. Revise the text to clarify the approach for collecting samples if there are no visual impacts, but sediment characteristics are heterogeneous.

NW Natural Response

The text has been revised in the referenced section of the DGWP to state that sediment depth intervals containing either homogenous or heterogeneous physical characteristics without signs of visual contamination will be sampled at the midpoint of the composite depth interval.

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[3] Gefell, M.J., M. Kanematsu, D. Vlassopoulos, and D. Lipson, 2018. "Aqueous-Phase Sampling with NAPL Exclusion Using Ceramic Porous Cups." *Groundwater* 56(6):847–851.

EPA Specific Comment 20

Section 3.2.2.1.1 PTW-NAPL Loading via Advection, Page 20. EPA comments on this section are as follows:

a. The first paragraph states that: "Advection is the flow of continuously connected PTW-NAPL through sediment pore spaces due to hydraulic gradients and PTW-NAPL density/buoyancy forces." EPA understands that this text is referring to advection of saturated product and not dissolved contaminant advection, but this is not clear from this statement. Revise text to clarify as appropriate.

   ### NW Natural Response

   To clarify this statement further, the beginning of this sentence has been changed from "Advection" to "PTW-NAPL advection."

b. The text for item no. 1 states that large-scale shake tests will be conducted to separate PTW-NAPL from sediment for analysis of fluid properties. While shake tests can be useful in confirming the presence of NAPL, provide the rationale for using shake tests exclusively for separating NAPL since centrifuging sediment samples after shaking would likely provide better separation and larger volumes of PTW-NAPL samples. Also revise the fluid properties being evaluated to include wettability, describe how the separated NAPL will be collected, and discuss the rationale for collecting up to six NAPL samples to determine fluid properties. This also applies to the discussions in Section 3.2.2.2.1.

   ### NW Natural Response

   The purpose of the large-scale shake tests is to collect opportunistic samples of visually mobile NAPL in the field during core processing as an additional line of evidence for NAPL fluid properties testing. NW Natural will also be completing centrifugation of cores during the NAPL mobility testing discussed in Section 3.2.2 of the DGWP. Anchor QEA has successfully collected pure NAPL samples from sediment cores at other sites using the proposed gentle shake-test method. If the NAPL is a dense nonaqueous phase liquid (DNAPL), centrifuging the material after gentle shaking could cause the NAPL to settle back into the sediment within the container, complicating separating the NAPL. The DGWP text has been revised to include wettability testing in accordance with the comment.

   During application of the large-scale shake test, surface tension characteristics cause either light nonaqueous phase liquid (LNAPL) or DNAPL to create a separate layer at the interface between air and water in the vessel. The NAPL is collected by carefully decanting it into a separate container. The testing laboratory performs a further "cleanup" process that separates the NAPL from any incidental water or solid particles. Up to six NAPL samples are proposed to account for possible differences in NAPL composition and weathering in the

Interim Project Area. The six samples will be collected from cores exhibiting a range of highly mobile NAPL (e.g., different colors, viscosities, and odors) in a range of sediment physical characteristics (e.g., sands and silts).

c. NW Natural should confirm sample freezing requirements with the laboratory.

NW Natural Response

Based on discussions with the laboratory, sample freezing is not required for any of the proposed laboratory analytical work.

EPA Specific Comment 21

Section 3.2.2.1.2 Gas Ebullition-Facilitated Transport of PTW-NAPL, Pages 21-22. Provide the rationale for the implementation of the high-level scans at low tide and during the late summer. Provide clarification if the additional focused scan to be conducted after the initial high-level scans for ebullition areas will also be conducted at low tide and in late summer. It is possible that additional scans at other time periods will not be able to confirm evidence of gas ebullition or sheen blossoms.

NW Natural Response

Based on existing literature and corroborated by experience at other sediment sites in EPA Region 2, gas ebullition is understood to be most prominent when water temperatures are highest and water levels are lowest. As stated in Section 3.2.2.2.2, NW Natural elected to perform gas ebullition sampling activities (high-level scans, focused scans, and data collection) at low tide during late summer for the following reason: "In an effort to collect the most conservative gas ebullition data (i.e., highest expected rates of gas ebullition), NW Natural proposes to perform the visual observations and data collection when the Willamette River is expected to have the lowest water levels of the year with warm temperatures."

The text has been revised to clarify the timing of the additional focused scan.

EPA Specific Comment 22

Section 3.2.2.1.2 Gas Ebullition-Facilitated Transport of PTW-NAPL, Page 22, Item 1, first bullet point. Include text discussing how it will be confirmed that the aerial photography does not miss sheen blossoms that would be visible to the human eye to ensure successful detection.

NW Natural Response

Due to easily adjustable camera lens positioning relative to potential sun and glare, it is anticipated that aerial photography will provide an equal or better image to determine areas with ebullition and sheening. That said, Section 3.2.2.1.1 of the DGWP was revised to state that high-level scans (aerial photography) and focused scans (Anchor QEA staff in a boat) will occur concurrently. Anchor QEA staff observing from a boat will be able to observe sheen blossoms that may be missed by aerial photography.

EPA Specific Comment 23

Section 3.2.2.1.2 Gas Ebullition-Facilitated Transport of PTW-NAPL, Page 22, Item 2, LOE 2. Provide clarification if the sheen duration can be quantified after sheen formation.

NW Natural Response

It likely would not be feasible to quantify sheen duration. Also, this step is not necessary for assessing ebullition-related mass flux and has not been performed at other sites where Anchor QEA has characterized sheen-bearing ebullition. Thus, it is not included in the proposed scope of the field program. No revisions were made to the DGWP based on this comment.

EPA Specific Comment 24

Section 3.2.2.1.2 Gas Ebullition-Facilitated Transport of PTW-NAPL, Page 22, Item 3. Add text describing how the geochemistry/oxidation reduction potential will be preserved to maintain field conditions and field gas generation rates.

NW Natural Response

Text has been added in the referenced section of the DGWP.

EPA Specific Comment 25

Section 3.2.2.1.2 Gas Ebullition-Facilitated Transport of PTW-NAPL, Page 22. The text states that: "These sample locations are within the areas where sheen was previously observed and gas ebullition may have occurred." Add a figure showing locations where sheens and gas ebullition are known or suspected to have occurred in the past.

NW Natural Response

The text was revised to describe the general locations where sheens and gas ebullition are suspected to have occurred in the past. The specific locations of gas ebullition and active surface sheening will be mapped following the high-level and focused scans to be completed during the upcoming data gaps sampling effort.

EPA Specific Comment 26

Section 3.2.2.2.1 PTW-NAPL Loading from Advection, Page 23. The text states that: "Core sections containing the most notable NAPL will be subjected to centrifuge testing with hydraulic gradients 25 times stronger than those that exist in situ to force NAPL to flow from the sample". Clarify whether the hydraulic gradients are 25 times greater than in situ gradients present at the

Gasco Sediment Site or 25 times greater than the force of gravity. Also provide information on how long these samples will be centrifuged, how the volume of NAPL extracted and the mass of NAPL remaining in the sample will be quantified, and how the saturation will be determined.

NW Natural Response

The cited text will be corrected to state: "Core sections containing the most notable NAPL will be subjected to centrifuge testing with hydraulic gradients equivalent to 25 times the force of gravity for 10 hours." The laboratory will measure the volumes of NAPL and water produced using a calibrated collection receiver that is placed beneath each centrifuged sample. The NAPL volume remaining in the sample will be quantified by Dean-Stark extraction. The laboratory will also measure the total sample volume and the sample porosity, bulk density, and grain density. The lab will calculate and report the initial and final NAPL saturations.

EPA Specific Comment 27

Section 3.2.2.2.2 Gas Ebullition-Facilitated Transport of PTW-NAPL, Page 24. Add the following details to this section:

a. The sediment samples for the biogeochemical reactive transport model will be a subset of the locations and intervals from the proposed depth of contamination (DOC) cores. It is unclear if the samples selected for this study will target the most visually impacted sediment samples based on ultraviolet light exposure/photography or other methods will be used to determine appropriate subsamples.

NW Natural Response

As stated in the Section 3.2.2.1.2 of the DGWP, the biogas generation potential sediment sample intervals will be "collected from 4 to 6 feet below the mudline in the intermediate region and 5 to 7 feet below mudline in the shallow region." These intervals were "selected to represent the range of variability in subsurface conditions with respect to organic carbon sources potentially supporting methanogenesis, including total organic carbon (TOC), TPAH, and total petroleum hydrocarbon (TPH) concentrations, measured during prior sampling programs." No ultraviolet light exposure/photography or other methods will be used to determine the samples for the biogas generation potential sampling objective.

b. The visual observations and videos/photos discussed in this section are limited to observing and quantifying sheen blossoms. Observations of bubbles being produced due to gas ebullition also need to be recorded, if observed.

NW Natural Response

The text was revised to include observations of bubbles being produced due to gas ebullition, if observed.

c. A table listing the modeling parameters and the sources of information for each parameter should be provided in the BODR. Also include the names of sites similar to the Gasco Sediment Site where the model has been used.

NW Natural Response

The requested information will be included in the BODR.

EPA Specific Comment 28

Section 3.2.3.1 Geotechnical Components Data Gaps Sampling Objectives and Sampling Design, Page 26. EPA comments on this section are as follows:

a. The text states that: "Each of the samples will be analyzed for moisture content, Atterberg limits, grain size, specific gravity, dry bulk density, one-dimensional consolidation, direct shear strength, and triaxial shear strength." Consolidation and strength testing should not be conducted on sonic boring samples as the samples are disturbed. In addition, ASTM D1586 cites concerns regarding the influence of vibrations on standard penetration test (SPT) blow counts with sonic drilling. Other more conventional drilling techniques (such as drive and wash) should be considered.

NW Natural Response

Moisture content, Atterberg limits, and grain size tests can be conducted on each sample, while dry bulk density, one-dimensional consolidation, direct shear strength, and triaxial shear strength tests will only be performed on undisturbed (Shelby tube) samples.

We are unaware of documented research that sonic drilling will disturb the sampling interval below the depth of drilling. To address the stated concern, SPT N-values will be checked against the cone penetrometer test (CPT) results to identify possible disturbance. The DGWP was revised to include two locations where the SPT and CPT tests are performed at the same location to facilitate a direct comparison. Further, in situ and laboratory test results will not be treated as absolute values for design purposes but will be considered as one of several data points (including local experience in similar soil units and correlations with index parameters) when assigning appropriate design strength and compressibility parameters for Interim Project Area sediments. Finally, due to the presence of contamination at the Interim Project Area, alternative drilling methods such as drive and wash or mud-rotary drilling were not considered due to the significant challenge of managing drilling fluids as investigation-derived waste (IDW).

b. The section indicates that geotechnical locations were selected based on cross sections developed in prior work phases. Provide the cross sections with relevant information highlighted for completeness and update Figure 8 to show existing data.

NW Natural Response

The cross-sections are included in Attachment C.

c. Provide the potential alignment for water quality containment engineering controls in the BODR, including a figure showing the conceptual lay-out of the controls.

NW Natural Response

The requested information will be included in the BODR.

d. The work plan does not make it clear how the scope of the data gaps geotechnical work will address geotechnical data collection objectives for stability, bearing capacity, and consolidation. Add a table correlating testing results to the components of the geotechnical investigation.

NW Natural Response

The requested information has been added to the DGWP.

e. NW Natural should consider running CPT logs near selected previously logged sediment borings and/or core locations to evaluate site-specific tool response to sediment types representative of the Interim Project Area.

NW Natural Response

NW Natural acknowledges that co-locating CPT and SPT locations can provide useful data for calibrating the CPT interpretation. One additional CPT location has been added on Figure 8 in the DGWP, co-located with a proposed SPT boring location. In addition, another set of proposed, closely located CPT and SPT explorations have been moved together so that these locations are now co-located. These two paired CPT/SPT co-locations will allow the engineering team to evaluate site-specific tool response to sediment types in the Interim Project Area.

EPA Specific Comment 29

Section 3.2.3.2 Geotechnical Components Data Collection Methods, Page 26. The second bullet point states that: "Refusal based on equipment or sampling setup limitations". Sampling setup limitations or physical equipment limitations should not dictate termination depths and contingency plans to make multiple attempts at a boring are required. Drilling methods, equipment and termination depths should be chosen to fulfill the investigation objectives and adequate materials and contingencies should be available to accomplish those objectives. As stated in the comment on Section 3.2.3.1, alternative drilling techniques may need to be considered for collection of geotechnical data.

NW Natural Response

Equipment limitation refusal is an issue for full-flow penetration (FFP) and CPT testing on a barge due to the physical ability of the instrument to penetrate denser soils. It may not be possible to advance a CPT to 65 feet below mudline if dense soils or bedrock is encountered—nevertheless, the CPT is a useful tool that should not be eliminated from the sampling program due to this inherent limitation. FFP testing will terminate if the upper measurement limit is reached.

Refusal due to equipment limitations is not expected for sonic borings. The text has been revised in the reference section to clarify the methods that may encounter refusal.

EPA Specific Comment 30

Section 3.3.1 Riverbank Remedy Evaluation Data Gaps Sampling Objectives and Sampling Design, Pages 27-28. EPA comments on this section are as follows:

a. Revise the text to specify the erosion evaluation that NW Natural will perform. Use of the BANCs model is consistent with EPA's riverbank guidance and it was used at the Siltronic site. The model is recommended for the Gasco Site and the data needs of the BANCs model should be met through riverbank data gaps sampling and analysis. If the BANCs model is to be used, provide a table comparing BANCs model input parameters to the information and data available for the riverbank, including the data to be collected during data gaps work.

NW Natural Response

As stated in response to EPA Specific Comments 5 and 34 in Appendix A of the TEWP, NW Natural has committed to reconfiguring the entire riverbank adjacent to the Gasco property, so no erosion evaluation of the existing condition or riverbank surface sediment/soil sampling is necessary or warranted. The reconfigured riverbank will be designed to account for the various technical evaluations summarized in Section 4.1 of the TEWP. No revisions were made to the DGWP based on this comment.

b. The section mentions the collection of bulk sediment data to support the riverbank capping demonstration. Include a discussion of the data to be used for evaluating the feasibility of PTW removal, including any handling or management requirements.

NW Natural Response

The text has been revised in the referenced section to identify the data to be used for evaluating the feasibility of PTW-NAPL and PTW-highly toxic removal, as well as the collection of six additional excavation/dredge material waste disposal suitability characterization samples from a portion of the proposed angled sonic borings. These additional sampling locations are shown on Figure 12 in the DGWP. See also response to EPA

Specific Comment 30d regarding the addition of riverbank soil and waste disposal suitability characterization samples on the Siltronic Corporation (Siltronic) property.

c. Provide the rationale for limiting the bottom depth of borings to be as deep as downgradient sediment sampling locations and the range of distance between proposed riverbank borings and downgradient sediment samples. Include a protocol for the condition where the bottom of the deepest sample is contaminated.

NW Natural Response

NW Natural has committed to reconfiguring the entire riverbank adjacent to the Gasco property. Because of this, NW Natural is only proposing to characterize the "wedge" of riverbank material between the uplands and the toe of slope along the Gasco and Siltronic (if required by EPA as discussed in the response to EPA Specific Comment 30d) riverbanks. If the bottom of the deepest sample is contaminated, no additional sampling will be completed because the directly adjacent subsurface sediment core data will be used to inform the design. No revisions were made to the DGWP based on this comment.

d. The text states that: "NW Natural understands the heavily armored Siltronic riverbank was constructed as a trapezoid of armor rock". Provide a reference to a document or correspondence that supports this statement. If available, include additional information and as-built cross-sections showing construction representative of the Siltronic riverbank in the DGWP or the TEWP for documentation and completeness.

NW Natural Response

NW Natural requested that Siltronic provide a reference to a document or correspondence supporting this understanding. Siltronic responded via email on August 7, 2019, and stated the following:

- Based on review of aerial photos, an undocumented class and thickness of riprap is present on the Siltronic riverbank as early as 1975 and remains in place through a 1996 flood as demonstrated in photos from 1994 and 1997 (i.e., pre- and post-flood).
- A repair of the riverbank in 1998 placed an additional 4 foot thick layer of class 1,000 and class 500 riprap along the entire Siltronic riverbank.
- Based on these findings, Siltronic believes the riprap present at the Siltronic riverbank is at least 4 feet thick, and in many areas is underlain by additional riprap placed during the initial bank construction.

Based on Siltronic's subsequent August 21, 2019 email to EPA, NW Natural understands that Siltronic is coordinating directly with EPA regarding the feasibility of collecting angled sonic borings along the top of the Siltronic riverbank. Due to the data gaps scheduled start date occurring as soon as possible in September 2019, the DGWP has been revised to include conditional collection of 4 angled riverbank borings. If EPA directs NW Natural to collect these borings, they will be collected using consistent sampling methods and chemical analyses described in the revised Section 3.3 of the DGWP. From two of the locations, waste disposal suitability characterization would be performed as described in revised Sections 3.5.1.3 and 3.5.2.3 of the DGWP. The boring locations are depicted on Figure 9 of the Work Plan.

EPA Specific Comment 31

Section 3.4 Dredging Evaluation, Pages 28-30. NW Natural proposes collecting samples to further evaluate the lateral and vertical extents of PTW-NAPL, PTW-NRC, PTW-highly toxic threshold, and RAL exceedances in the riverbank. Revise the text in this section to include information on how the vertical and lateral extent of contamination will be defined. Also confirm that a minimum of 22-samples will be submitted for analysis. Provide clarification for not including information from uplands borings within a lay-back distance of a 5:1 slope.

NW Natural Response

Section 3.4 of the DGWP evaluates dredging in sediment areas outside the riverbank and states, "In dredge and cover areas, the three-dimensional dredge prism should achieve removal, to the extent practicable, of the full extent of RALs, PTW-highly toxic/NRC (if applicable) thresholds, and PTW-NAPL. In dredge and cap areas, the three-dimensional dredge prism design should achieve removal to the design depth or elevation prior to cap placement. In addition, the dredging evaluation will support the identification of dredge management units (DMUs). The dredge prism design will consider the performance standards and design objectives presented in TEWP Section 4.2.1." Consistent with this text, the vertical and lateral extent of contamination will be defined based on comparison of the existing and proposed surface and subsurface sediment concentrations to the ROD Table 21 PTW-highly toxic thresholds and site-specific PTW-NRC thresholds (if applicable based on the BODR capping demonstrations), and the presence of PTW-NAPL using the site-specific definition based on visual observations.

The DGWP scope of work does not identify the collection of 22 samples in Section 3.4, so this sampling density cannot be confirmed. The sampling density associated with dredging evaluations is detailed in the FSP Table A-3. The sampling density for riverbank is included in FSP Table A-2 and identifies the collection of 34 sample intervals at 12 locations.

Nine upland borings were collected by NW Natural along the top of riverbank at the Gasco and Siltronic properties, and the findings were reported in Section 3 of Appendix A in the Draft EE/CA. This information is included in the DGWP because a lay-back distance of a 5 horizontal:1 vertical slope would result in a reconfigured riverbank slope that would destroy the existing hydraulic control and containment system (HC&C) system infrastructure (described in TEWP Section 3.6.3). That slope configuration is not required to achieve the design objectives of the ROD, so it was not incorporated in the DGWP.

No revisions were made to the DGWP based on this comment.

EPA Specific Comment 32

Section 3.4.2 Dredging Evaluation Data Collection Methods, Page 30. The second bullet point indicates that in situations where analysis of either of the two bottom depth sample intervals detects concentrations of a parameter that exceeds ROD Table 21 values, the core will be considered unbounded and the DOC will be evaluated using the framework in Section 3.4.3. Section 3.4.3 is missing from the document. The DOC framework also does not appear to be explained in Section 3.4.3 of Appendix A. Revise text as appropriate.

NW Natural Response

The text has been revised to identify the correct reference is Section 3.4.1.

EPA Specific Comment 33

Section 3.5.1.1 Dredge Material Handling and Transport Evaluation, Page 32. NW Natural characterizes elutriate generation activities as being “short term and intermittent,” and indicates that construction will only occur during a portion of the day. NW Natural uses this information to propose acute water quality criteria for discharging elutriate to the Willamette River. Although, daily discharges are projected to be low, actual volumes are currently unknown and volumes for a construction season may be large. Based on available information, discharging elutriate water to the river at concentrations greater than acute water quality criteria is not a preferred option. Consequently, NW Natural should evaluate additional alternatives, including segregating elutriate water for transfer to the uplands for treatment through the Gasco Site water treatment plant. Note that discharges to the river may involve further review by the Oregon DEQ Water Quality Program of elutriate constituents, testing methods, and discharge criteria and may require comparison with chronic water quality criteria. Additionally, the text states that: “Consistent with EPA’s Specific Comment 2 in Appendix D, NW Natural will analyze the dredge dewatering elutriate samples for the ROD Table 17 chemicals with groundwater cleanup levels.” Revise this list to include all Table 17 COCs with surface water cleanup levels, especially to include dioxin/furan analyses. An appropriate water quality criterion for the dioxin/furans can be discussed with EPA and DEQ.

NW Natural Response

NW Natural agrees that any dredge material haul barge elutriate discharges into the Willamette River during construction should be evaluated using applicable promulgated freshwater acute criteria. These criteria should be applied at the edge of a construction mixing zone, the dimensions of which would be determined in consultation with EPA during remedial design. If the pre-remedial design sampling data identify that the elutriate may exceed the applicable criteria during construction, NW Natural will evaluate water treatment prior to discharge to the Willamette River or an alternate means of water management and disposal. NW Natural understands that the Oregon Department of Environmental Quality (DEQ) Water Quality Program may provide input to the water quality monitoring program.

Revisions have been made to the referenced section of the DGWP to analyze the dredge dewatering elutriate samples for those chemicals containing ROD Table 17 surface water cleanup levels that have applicable acute water quality criteria or reliable acute ecological screening values for surface water. The previous DGWP text inadvertently identified analysis of chemicals with ROD Table 17 groundwater CULs, which is not applicable to surface water discharges. Although dioxins/furans have a surface water CUL, there are no state or federal aquatic life (acute and chronic) water quality criteria for dioxins; therefore, construction monitoring for dioxins should not be required. Aquatic life criteria are not readily available because dioxin toxicity occurs primarily through bioaccumulation, which is not representative of short-term construction activities. No revisions were made to the DGWP based on this comment.

EPA Specific Comment 34

Section 3.5.1.2 Dredge Material Disposal Suitability Testing, Page 32-33. Comments regarding the section include the following:

a. The Gasco Sediments Site SOW states that the single sample per 10,000 cubic yards will be a composite of 3 core locations. Provide the rationale for inconsistencies with the SOW. Sample density does not apply to volumes of sediment that due to regulatory, material handling, and disposal considerations, require separate evaluation. A single composite sample is insufficient to evaluate the volume of sediment potentially containing F002 listed hazardous waste within the Interim Project Area. The sampling program should delineate the volume of F002-impacted sediment to support a contained-in determination. This information is necessary for planning dredging, material handling (e.g., segregation), transport, and disposal.

NW Natural Response

Consistent with Section 3.6.3.1 of the SOW, Section 3.5.1.2 of the DGWP proposes that dredge material be characterized for F002 wastes via bulk sediment chemical analyses of trichloroethylene (TCE), cis-dichloroethylene (DCE), trans-DCE, 1,1-DCE, and vinyl chloride. NW Natural plotted the subsurface and surface sediment concentrations for these chemicals identified to date throughout the Interim Project Area and compared them against the risk-based concentrations (RBCs) identified in the May 2018 "Risk-Based Concentrations for Individual Chemicals" table (DEQ 2018). These comparisons are depicted in Attachment D and show only a single subsurface sediment location contained exceedances of TCE and four locations for vinyl chloride. However, all four locations that exceeded the vinyl chloride RBC were due to non-detectable concentrations at an elevated detection limit above the RBC. Regardless, due to these exceedances, the figures in Attachment D show that NW Natural is proposing the collection of dredge material waste disposal suitability cores in these specific areas to further assess the F002 waste chemical sediment concentrations. If the identified concentrations exceed the RBCs, NW Natural will perform the dredge material stabilization testing described in Section 3.5.1.2 of the DGWP to evaluate the effectiveness of amendment addition reducing the sediment concentrations below the RBCs.

b. The section indicates that 22 sediment samples have previously been collected from within the Interim Project Area and tested using the TCLP. The results of the testing are not discussed and/or provided. The information is needed to support NW Natural's proposal to use apply these results to the samples estimated as being needed for data gaps sampling 33-samples total).

NW Natural Response

Results of previous TCLP testing within the Interim Project Area at 22 locations are reported in Section 4.1.5.2 of the *Public Review Draft Engineering Evaluation/Cost Analysis – Removal Action, NW Natural "Gasco" Site* (Anchor Environmental 2005), Sections 5.1 and 5.4 of the EPA-approved *Final Project Area Identification Report – Gasco Sediments Site* (Anchor QEA 2010), and Sections 2.6.1 and 2.6.4 of the *Draft Engineering Evaluation/Cost Analysis – Gasco Sediments Cleanup Site* (Anchor QEA 2012). Specifically, these results, all of which are associated with a single subsample from a single core interval, showed the following:

- Only two of four TCLP analyses samples performed in 2004 contained benzene leachate results that exceeded TCLP Maximum Concentration of Contaminants for the Toxicity Characteristics criterion (40 CFR §261.24 Table 1), and bench scale testing showed that amendment addition (consistent with Section 3.6.3.1 of the SOW) decreased the benzene concentration below the criteria. Both of these tar sample locations were removed during the 2005 Removal Action, so these materials are no longer present in the Interim Project Area.
- No TCLP criterion exceedances were identified from eight TCLP analyses performed in 2009. The eight locations were determined based on a review of the aerial extents and depth of identified contamination, including the presence of mobile product. Subsampling from each core was performed preferentially in the portion of the core showing the highest potential for chemical mobility (e.g., saturated, heavy sheen, and visible oil) to characterize those sediments with the greatest potential for exceeding the TCLP criteria.

- Only 2 TCLP criteria exceedances for benzene leachate were identified from seven TCLP analyses performed in 2010. However, bench scale testing showed that variable concentration amendment addition decreased the leachate concentrations below the TCLP criteria. The location determination and preferential sampling within each core for the highest potential for chemical mobility was performed consistent with the 2009 TCLP sampling.

The above results were specifically collected throughout the Interim Project Area in depth intervals that had the highest potential for elevated benzene concentrations and showed no TCLP exceedances following ex situ treatment with amendments.

NW Natural believes the collection of a total of 37 samples for toxicity characteristic leaching potential (TCLP) analyses strategically located within the Interim Project Area (i.e., to address spatial concentration differences and conservatively targeting elevation concentration areas) is sufficient to proceed with remedial design.

The proposed waste suitability sampling density is consistent with the SOW because dredge management units (DMUs) have not yet been established within the Interim Project Area. DMUs will not be developed until the following actions are complete: the data gaps sampling is completed, the dredging evaluations described in the TEWP are completed and remedial technologies are assigned consistent with the ROD, and a myriad of engineering evaluations are completed (e.g., determination of the dredge prism, slope stability, the necessary offsets to protect functional structures and top of riverbank source control equipment, dredging durations to achieve the placement of residual management cover approximately every 10 to 14 days as described in Appendix E of the TEWP). Finally, this pre-characterization work is intended only to inform design. Although the existing and proposed dredge material disposal suitability and stabilization testing results will be used to develop the design, NW Natural will perform field verification (i.e., barge testing during construction) for both of these disposal issues to ensure the design is protective, consistent with Section 3.6.3.1 of the SOW. NW Natural acknowledges that if the data gaps sampling identifies sediments containing either Special Wastes or Hazardous Wastes following the stabilization testing, additional waste suitability sampling may be necessary to refine the vertical lateral footprints of these materials to support remedial design of dredge material management.

c. The section indicates that the goal of the work is to develop an approach for stabilizing sediment to "pass the paint filter test and meet the minimum structural strength required by the disposal facility." The need for this testing appears to be separate from TCLP analysis of sediment. Consequently, more than 11-samples may need to be collected to provide paint filters and/or structural strength information. Include sufficient information to show that data gaps sampling will meet project needs in terms of providing sufficient treatability testing results for evaluating amendment effectiveness and determining dosage rates for potential dredge material throughout the Interim Project Area.

NW Natural Response

NW Natural confirms the need for paint filter and material strength testing is separate from the TCLP analysis. The proposed additional 12 samples (note that an additional sample was added) will be used to support remedial design for dredge material handling and disposal, but achievement of the dredge material handling and disposal facility requirements will be based on field verification sampling during construction. Based on lessons learned during completion of the Gasco Tar Body Early Action construction, the range of sediment physical properties identified in the Interim Project Area, and experience at other cleanup sites, 12 additional samples is adequate to provide sufficient treatability testing results for evaluating amendment effectiveness and determining dosage rates for dredge material management throughout the Interim Project Area during remedial design. Remedial design will also be informed by past disposal treatment bench scale free liquid and bearing capacity testing in 2004. These results are discussed in Section 5.4 of the EPA-approved *Final Project Area Identification Report – Gasco Sediments Site* (Anchor QEA 2010). In summary, approximately 5 percent (by weight) Portland cement met the 1 ton per square foot requirement in 1 day of curing time. Actual construction observations indicated that a 5 percent dosage was too low to remove all free liquid, likely due to inability to completely mix the reagent into a barge load of sediments. Consequently, on average approximately 10 percent of Portland cement was used during actual construction.

EPA Specific Comment 35

Section 3.5.1.2 Dredge Material Disposal Suitability Testing, Page 33. The footnote states that there will be no testing for reactivity, as stipulated in the SOW, because "NW Natural has no knowledge or reason to believe that the Gasco Sediments Site dredged material is reactive". While this is acceptable to EPA, this may be a disposal facility requirement and NW Natural should confirm with prospective waste disposal facilities before foregoing this analysis. NW Natural also indicates that designation of this characteristic is now based on the generator's knowledge, and the company has no knowledge or reason to believe that the Gasco Sediments Site dredged material is reactive. The reactivity characteristic (D003) applies to waste that meet any one of eight criteria listed in §261.23(a). Document the basis of the company's knowledge in terms of these criteria.

NW Natural Response

NW Natural has confirmed that there are no disposal facility requirements to test for the reactivity characteristic. The eight criteria are listed below in **bold text** with the basis of NW Natural's knowledge in terms of each criteria in regular text.

1. **It is normally unstable and readily undergoes violent change without detonating.** The sediment is stable and would have violently changed by now if that was its inclination.
2. **It reacts violently with water.** The sediment is under water and would have reacted violently with water if that was its inclination.
3. **It forms potentially explosive mixtures with water.** See response to criterion 2.
4. **When mixed with water, it generates toxic gases, vapors or fumes in a quantity sufficient to present a danger to human health or the environment.** The sediment is currently mixed with water. Numerous sediment investigations at various depths nave been conducted in the Interim Project Area with air quality monitoring, and there has been no evidence of toxic gases, vapors, or fumes.
5. **It is a cyanide or sulfide bearing waste which, when exposed to pH conditions between 2 and 12.5, can generate toxic gases, vapors, or fumes in a quantity sufficient to present a danger to human health or the environment.** There have been numerous sediment investigations at various depths throughout the Interim Project Area with air quality monitoring, and there has been no indication that toxic gases, vapors, or fumes have been generated.
6. **It is capable of detonation or explosive reaction if it is subjected to a strong initiating source or if heated under confinement.** The sediment is not an explosive material and, to the best of NW Natural's knowledge, does not contain residues of explosives.
7. **It is readily capable of detonation or explosive decomposition or reaction at standard temperature and pressure.** See response to criterion 6.
8. **It is a forbidden explosive as defined in 49 CFR 173.54, or is a Division 1.1, 1.2, or 1.3 explosive as defined in 49 CFR 173.50 and 173.53.** See response to criterion 6.

EPA Specific Comment 36

Section 3.5.2.1 Dredge Material Waste Handling and Transport, Page 34. The text in this section requires a more detailed step-by-step explanation of how the vertically composited sample will be collected. Provide clarification if this will be done after DOC samples have been collected or before the 1-foot core intervals for the DOC cores have been archived.

NW Natural Response

As discussed during the July 22, 2019 core processing procedures technical briefing presented by Anchor QEA and NW Natural (Appendix J of the DGWP), the vertically composited dredge material waste handling and transport samples will be collected from a separate core than the DOC samples will be collected from. The text has been revised to reflect this approach.

EPA Specific Comment 37

Section 3.6.1 Additional Analyses Data Quality Objectives and Sampling Design, Page 34. This section references COCs that have been shown to likely govern remedial design. Revise the text to list these COCs and include the basis for this statement. In addition, explain the term "comprehensive hydrocarbon analysis."

NW Natural Response

The text has been revised in the referenced section to identify PAHs, VOCs, and arsenic consistent with the findings of Appendix D in the TEWP. As shown on Table 4h of Appendix B to the DGWP, comprehensive hydrocarbon analysis for the additional analyses includes alkylated PAHs, petroleum biomarkers, and saturated hydrocarbons.

EPA Specific Comment 38

Section 3.6.2 Additional Analyses Data Collection Methods, Page 35. This section proposes analyzing select samples for stable isotope and bulk elements. The purpose of these analyses is "further characterize hydrocarbon residuals." Provide clarification for the use of this data to inform the project needs.

NW Natural Response

These data will be collected to assist in source identification.

EPA Specific Comment 39

Section 4.1 Report Contents, Page 36. The BODR should include figures that display data both laterally and vertically. Data generated during the data gaps investigations, including the sampling results from NW Natural Proposed Spring 2018 Interim Pre-Remedial Design Data Gaps Field Sampling – Gasco Sediments Site memorandum dated April 3, 2018 and the results of previous co-located porewater/sediment analyses, should be submitted to EPA electronically.

NW Natural Response

The BODR will include the requested information. The requested data will be submitted to EPA electronically following receipt of the data gaps investigations validated data and incorporation into the Gasco Sediments Site database.

EPA Specific Comment 40

Figure 3. EPA comments related to Figure 3 are as follows:

a. Provide clarification for why RAL exceedances outside the project area are not included in the natural neighbor interpolation footprints, for example the orange dot near the downstream end of the site in the navigation channel.

   NW Natural Response

   The RAL exceedances outside the Interim Project Area were not included in the natural neighbor interpolation footprints to focus the reader on the data trends within the Gasco Project Area.

b. Note that the Explanation of Significant Differences (ESD) is not yet finalized, as stated in the figure notes. Therefore, it is acceptable to show these RALs for informational purposes only, but they should not be interpreted as final RALs until the ESD is finalized.

   NW Natural Response

   NW Natural understands the ESD is not yet finalized and that the RALs are not final until the ESD is finalized.

c. Include a discussion on how the "Gasco Sediments Site Interim Project Area Within the EPA-identified Gasco Project Area" boundary was developed.

   NW Natural Response

   The Interim Project Area was established in the Draft EE/CA within the Gasco Sediment Site under the Gasco Administrative Settlement Agreement and Administrative Order on Consent. The ROD identifies SMAs, and the SMA associated with the Gasco Sediment Site was used to refine the Interim Project Area. Figure 3 of the June 10, 2019 Work Plan, therefore, presents the revised Interim Project Area that is identical to the ROD-identified SMA within the Gasco Sediments Site.

EPA Specific Comment 41

Figure 5. The text associated with the Geotechnical Filter Layer provides information in the context of the layer being necessary. If the geotechnical filter layer is not necessary, the approach to long-term porewater monitoring may be affected. Both the cap design and porewater monitoring approach should be developed in tandem to ensure that the cap modeling assumptions align with future monitoring requirements.

NW Natural Response

Consistent with the comment, the cap design and long-term monitoring requirements developed in tandem collaboratively with EPA and described in the *Summary of Final Cap*

Modeling and Long-Term Cap Monitoring Approach – Gasco Sediments Site submitted to EPA on June 25, 2019. This approach includes the monitoring of porewater directly above the chemical isolation layer so if a filter layer is not required during remedial design, the monitoring would be conducted in whatever layer directly overlies the isolation layer.

EPA Specific Comment 42

Figure 6. The locations of the proposed capping only cores appear to be based on the ROD-based technology assignments, suggesting that NW Natural has decided to cap in these areas and will not perform a dredging evaluation. The remainder of the intermediate region appears to consider both dredging and capping technologies. Provide the rationale for not evaluating dredging in the ROD-designated cap areas. Sufficient data should be collected in the intermediate region to fully evaluate both dredging and capping technologies.

NW Natural Response

See response to EPA General Comment 8.

EPA Specific Comment 43

Figure 7. The middle green box states that “some combination of the following tests/methods will be performed.” Provide clarification on how it will be determined which methods to use for ‘Testing Above NAPL Interval’. Additionally, material type should be considered as a factor in selecting depth intervals containing the highest apparent NAPL saturation with priority given to mobility testing on NAPL-containing intervals in coarser sediments. That said, cores with fine-grained intervals and coarse-grained intervals should be evaluated to develop testing information for a variety of sediment types.

NW Natural Response

The Figure 7 flow chart has been modified to clarify that NAPL mobility testing will be conducted in a staged manner, such that the testing indicated in green (Stage 2) will only occur if NAPL mobility is observed based on centrifuge testing (Stage 1, indicated in light blue). Stage 1 NAPL mobility test samples will be selected from a variety of the sediment types that contain notable NAPL saturation based on core photography, including coarser sediments. If NAPL mobility is observed in Stage 1, the methods that will be used in Stage 2 will depend on whether or not NAPL is successfully separated from sediment for fluid properties testing. Details regarding this part of the testing program will be discussed with EPA before conducting the testing.

EPA Specific Comment 44

Figure 11. There appears to be a gap in the coverage of the proposed dewatering cores from between the “Tar Body Removal Action Pilot Cap,” upstream of the Gasco and Siltronic site

boundary, and out to the navigation channel. Review the figure and add additional cores to fill the gap, as needed.

NW Natural Response

The dewatering core locations were chosen to provide both spatial coverage (six in the channel and six outside the channel) and to represent anticipated concentration PAH concentration ranges based on the existing data within the Interim Project Area. Further, these are co-located with the waste characterization cores, and previous data exist from four cores between the Tar Body Removal Action Cap and the Siltronic boundary. No revisions were made to the DGWP based on this comment.

EPA Specific Comment 45

Figure 13. This figure identifies locations for analysis of "non site-specific" COCs, however many of these COCs are located and exceed RALs within the project area (e.g., PCBs, DDx). Provide clarification for the term "non-site specific" and retitle the figure as needed.

NW Natural Response

Historical and current operations at the Gasco property did not include sources of PCBs, DDx, or dioxin/furans so they are categorized as non-site specific COCs. No changes have been made to the DGWP, and this categorization will not affect remedial design decisions (although the extent and concentration of these and other COCs may).

EPA Specific Comment 46

Appendix A – Field Sampling Plan, Section 3.1 PTW-NAPL Identification, Page 3. It is unclear how the "full depth of each sediment grab sample" will be inspected for PTW-NAPL. Provide clarification whether the text is referring to the three-point composite sample collected from the grab samples or will the entire depth of the Van Veen grab samples be inspected for PTW-NAPL. The same clarification is also needed for the last paragraph of Section 3.2.2.1.

NW Natural Response

The entire depth of each individual grab sample collected will be inspected for PTW-NAPL. The text in Section 3.1 has been revised to reflect that each individual sample will be inspected for PTW-NAPL, and Section 3.2.2.1 has been revised to further describe the method.

EPA Specific Comment 47

Appendix A – Field Sampling Plan, Section 3.2.1 Surface Sediment Sampling Plan, Page 4. Based on the first bullet point it seems that only surface sediment data will be used to refine the project area. As indicated during the March 20-21, 2019 EPA workshops, surface and subsurface exceedances of RALs are to be used for SMA delineation. Revise the text to include the use of subsurface data in addition to surface data for refining the project area. This comment also applies to Section 3.2.2.1.

NW Natural Response

See response to Specific Comment 7.

EPA Specific Comment 48

Appendix A – Field Sampling Plan, Section 3.2.1 Surface Sediment Sampling Plan, Page 4. The text states that four surface samples will be collected to refine the project area boundary and five samples will be collected to provide additional data densities. These numbers are inconsistent with the sample locations shown in Figure A-2 and listed in Table A-1. Resolve these inconsistencies.

NW Natural Response

The sample numbers in the referenced section in the FSP and Table A-1 have been revised.

EPA Specific Comment 49

Appendix A – Field Sampling Plan, 3.2.2.1 Interim Project Area Refinement and Additional Surface Sediment Data Density, Page 5. The text states that: "If no material is recovered after two attempts at a subsample location, the location will be offset to a maximum of a 50-foot radius from the target location." EPA requests that three attempts be made at each subsample location before moving to a 50-foot radius and three attempts should be made at the 50-foot radius alternate location as well.

NW Natural Response

The FSP has been revised to state that no more than six individual subsample attempts will occur at each composite location, and the three attempts with the highest recovery will be retained. If the composite average is greater than 0.3 feet, the sample will be retained for analysis. This approach is consistent with the recent EPA-approved surface sediment sampling performed by the Port of Portland at the Terminal 4 site.

EPA Specific Comment 50

Appendix A – Field Sampling Plan, Section 3.2.2.2 Early Action Area Pilot Cap Depositional Sediment, Page 6. The text states that: "Multiple samples that are slightly offset may need to be collected from a single station if the thickness of depositional sediment is insufficient for laboratory analyses of the target analyte list." Revise the text to quantify what is meant by "slightly offset".

NW Natural Response

The text has been revised to clarify that multiple samples will be collected from within 20 feet of the target location.

EPA Specific Comment 51

Appendix A – Field Sampling Plan, Section 3.3 Riverbank Angled Borings, Page 8. EPA understands that no riverbank borings are proposed at the Siltronic property due to the trapezoidal armor construction at this bank. See general comment discussing riverbanks.

NW Natural Response

See response to EPA Specific Comment 30d.

EPA Specific Comment 52

Appendix A – Field Sampling Plan, Section 3.3.4 Soil Boring Abandonment, Page 10. The text states that: "For intervals where NAPL is present, the grout slurry will consist of a bentonite/organoclay blend…". Add clarifying text to indicate the basis for determining the presence of NAPL (e.g. based on visual observations in the borehole sample).

NW Natural Response

The text has been revised to state that the basis of determining NAPL will be visual observation of recovered soil sampled for presence of PTW-NAPL.

EPA Specific Comment 53

Appendix A – Field Sampling Plan, Section 3.4 Subsurface Sediment Sampling, Pages 10-17. Add a subsection discussing details of the centrifuge test procedures. A description of the centrifuge test is needed which includes details such as test method, volume, durations, etc.

NW Natural Response

The requested subsection has been added to Appendix A that includes the requested information.

EPA Specific Comment 54

Appendix A – Field Sampling Plan, Section 3.4.2 Subsurface Sediment Collection Methods, Page 12. This section is lacking details about use of core tube liners, core catchers, etc. Expand the discussion to include such details.

NW Natural Response

The text has been revised to reflect that each individual core tube will be fitted with a stainless-steel core catcher at the bottom end. Subsurface sediment samples will be collected directly into the core tube without the use of a core liner.

EPA Specific Comment 55

Appendix A – Field Sampling Plan, Section 3.4.2 Subsurface Sediment Collection Methods, Page 13. Add the following to the list of acceptability criteria for core collection:

a. Overlying water is present, and the core surface is intact

NW Natural Response

The text has been revised in the referenced section of the DGWP.

b. Core tube is in good condition and not excessively bent

NW Natural Response

The text has been revised in the referenced section of the DGWP.

EPA Specific Comment 56

Appendix A – Field Sampling Plan, Section 3.4.2 Subsurface Sediment Collection Methods, Page 13. The text states that: "The core sections will be stored approximately upright in iced containers in the appropriate orientation until core processing is conducted." If cores are anticipated to be on the vessel for extended periods before being transferred to the processing facility, EPA expects that the cores will be stored upright and on ice aboard the vessel. Revise the text to indicate definitively that the storage procedures will be followed both onboard the vessel and at the processing facility until core processing is performed.

NW Natural Response

The text has been revised to reflect that cores will be kept upright at all times, both on the sampling vessel, during transport, and in the processing area. Also, ice will be added to core storage box if cores are kept on the sampling vessel for extended periods of time (e.g., not transferred mid-day or at the end of the day).

EPA Specific Comment 57

Appendix A – Field Sampling Plan, Section 3.4.5 Shake Test Procedures, Page 17. Provide justification for the time range provided in bullet 2.e. and explain why a minimum of 5 minutes will allow acceptable separation. Text clarification is also needed on what is meant by "using the same large-scale shake test jar" in bullet point 6 (e.g. the same type of jar or the same jar used for the previous sample).

NW Natural Response

Anchor QEA has successfully collected pure NAPL samples from sediment cores at other sites using the specified procedure, including the time range indicated in this section. Bullet 6 has been reworded for clarity.

EPA Specific Comment 58

Appendix A – Field Sampling Plan, Section 3.5.3 Subsurface Porewater Sampling Procedures and Processing, Page 20. Revise the text to define what is meant by "sufficient recovery" in the tenth item on page 20.

NW Natural Response

The text has been revised in the referenced section of Appendix A.

EPA Specific Comment 59

Appendix A – Field Sampling Plan, Section 3.6.1 Gas Ebullition Monitoring Sampling Plan, Phase 2 Gas Ebullition Monitoring, Page 21. Revise the text as follows: "Focused visual observations (i.e., Line of Evidence 1 described in Section 3.2.2.1.2 of the DGWP) will be concurrently documented by video recordings (i.e., Line of Evidence 2) in areas with observations of gas ebullition and/or active sheen blossoms during Phase 1 gas ebullition monitoring program."

NW Natural Response

The text has been revised in the referenced section of Appendix A.

EPA Specific Comment 60

Appendix A – Field Sampling Plan, Section 3.6.2.2 Phase 2 Focused Gas Ebullition Observations, Page 22. While recording focused observations of apparent gas ebullition or active sheen blossoms, water depth should also be observed and recorded. Revise the text and field form to include these observations.

NW Natural Response

The text and field form have been revised.

EPA Specific Comment 61

Appendix A – Field Sampling Plan, Section 3.6.2.2 Phase 2 Focused Gas Ebullition Observations, Page 24. The second sub-bullet point states that sheen blossom frequency will be recorded "by counting and recording the number of active sheen blossoms that appear during a period in an approximately 10-foot by 10-foot area". Clearly define the time period over which the blossoms will be recorded. Include discussion of a standardized way of determining the 10-foot by 10-foot area so there are not major deviations between different field personnel logging the observations. Additionally, in the third bullet, video of gas ebullition should be recorded for at least 2 minutes.

NW Natural Response

The text has been revised to reflect that counting and recording of active sheen blossoms will be conducted for 5 minutes. The text has also been revised to include a standardized way to determine the 10×10-foot area of observation. Video of gas ebullition recording time has been revised to 2 minutes.

EPA Specific Comment 62

Appendix A – Field Sampling Plan, Section 3.7.1 Ebullition Sheen Sampling Plan, Page 25. The text states that: "NW Natural anticipates that between 5 and 10 sheen [sic] active sheen blossom samples will be opportunistically collected…" Note that EPA expects that the 5 to 10 opportunistic sheen samples will be collected at 5 to 10 different locations. Multiple samples collected at the same location will not fulfill this requirement.

NW Natural Response

NW Natural agrees with targeting the opportunistic samples in 5 to 10 different locations. NW Natural defines one location as being a 10×10-foot grid (see response to Specific Comment 61). Within this area, if active sheen blossoms are observed, one sheen net will be used to collect a representative sample for that location. The number of actual samples available to be collected will be determined based on active sheen blossoms observed.

EPA Specific Comment 63

Appendix A – Field Sampling Plan, Section 3.8.2 Biogas Generation Potential Sampling Methods, Page 27. NAPL may also serve as a source of organic matter for biogas generation. Provide clarification if the sample intervals selected will all have presence of PTW-NAPL.

NW Natural Response

A key goal of sample location selection is to include sediments containing NAPL. The locations and depth intervals were selected to include areas of potential PTW-NAPL based on the previously observed lateral extent of PTW-NAPL and previously reported TOC/PAH concentrations. The proposed sampling is anticipated to include samples with a range of NAPL concentrations.

EPA Specific Comment 64

Appendix A – Field Sampling Plan, Section 3.9.2.3 Geotechnical Sample Processing, Page 29. The last paragraph states that: "Laboratory test assignations will be determined by the field coordinator in consultation with the project geotechnical engineer based on the encountered sediment types." Provide additional information as to what those tests and selection criteria might be. Also, consider replacing "assignations" with "assignments".

NW Natural Response

Additional detail regarding the determination of laboratory assignments has been added the referenced section in Appendix A. "Assignations" was replaced with "assignments."

EPA Specific Comment 65

Appendix A – Field Sampling Plan, Section 3.9.3 In Situ Penetration Testing, Pages 29-30. Provide clarification if any pore pressure dissipation tests are planned as part of the cone penetration test scope.

NW Natural Response

Details regarding pore pressure dissipation testing have been added to the referenced section in Appendix A.

EPA Specific Comment 66

Appendix A – Field Sampling Plan, Section 3.9.3.2 In Situ Penetration Testing Methods, Page 30. The last bullet point states that: "Because physical samples are not obtained using CPTu or FFP, IDW management and disposal is unnecessary." Consider whether this process will generate decontamination water or used gloves or other investigation derived waste (IDW). If so, include information on managing these types of IDW.

NW Natural Response

The bullet has been revised in the referenced section of Appendix A.

EPA Specific Comment 67

Appendix A – Field Sampling Plan, Section 3.11.2 Field Blanks, Page 31. Specify the frequency of rinsate blank and field blank collection.

NW Natural Response

The text has been revised to specify a frequency of weekly.

EPA Specific Comment 68

Appendix A – Field Sampling Plan, Section 3.12.2 Field Quality Assurance/Quality Control Sample Identification, Page 33. It may be helpful to modify the sample identification described for rinsate blanks to also include identification of the type of equipment that the rinsate blank was collected from. Additionally, the sample numbering scheme of adding 100 to the sample location ID number, so 101 is a duplicate of 01 may not be adequate if the goal is to submit blind samples to the laboratory. Also, there are some station IDs with numbers 100 and up, so this may create confusion using the proposed methodology. For example, PDI-111 is an in-situ penetration test location and is not located near PDI-011 which is a core sampling location, based on figures A-8 and A-11 in the July 3, 2019 addendum. Adjust the sampling identification methodology to include and be consistent with the additional samples that were added in the addendum.

NW Natural Response

The duplicate identifier has been revised to include adding 1000 to the station ID instead of 100 and a two-letter identifier has been added for field blank (FB) and rinsate blank (RB) collection methods.

EPA Specific Comment 69

Appendix A – Field Sampling Plan, Section 4.1 Field Documentation, Page 34. The text states that: "Surface sediment sample, sediment core, gas ebullition observation, and soil boring collection log sheets will be completed for each sampling location (sample log sheets are presented in Attachment A)." Revise the list to include the porewater collection log sheet also provided in Attachment A. Note that any deviations from the approved DGWP and FSP need to be reported to EPA for approval as soon as possible and recorded in field deviation forms.

NW Natural Response

The text has been revised to include the porewater collection log. Deviations will be recorded on field deviation forms.

EPA Specific Comment 70

Appendix A – Field Sampling Plan, Section 4.4.1 Management of Investigation-Derived Waste, Page 37. This section provides the list of analytes for IDW characterization. Consider including polychlorinated biphenyls (PCBs) for IDW characterization as the disposal contractor will require that information for disposal determination. Include the footnote about reactivity testing from the DGWP (Section 3.5.1.2) in this section for completeness and see the specific comment on Section 3.5.1.2 of the DGWP above.

NW Natural Response

Based on discussion with disposal contractors, IDW characterization for PCBs is only required if the generator has knowledge the concentrations could approach the Toxic Substances Control Act (TSCA) threshold of 50,000 micrograms per kilogram (μg/kg). The highest total PCBs concentrations detected within the Interim Project Area from a significant number of surface and subsurface sediment samples is 4,900 μg/kg. This concentration is less than 10 times lower than the TSCA threshold. Therefore, PCBs are not included in the IDW characterization.

EPA Specific Comment 71

Appendix A – Field Sampling Plan, Section 4.4.2 Management of Surface Water Sheens, Page 38. It is unclear which agency the Office of Spill Prevention Section is associated with. Clarify and/or correct the name of this office. In addition to notifying the Office of Spill Prevention, EPA will also be notified as soon as possible. Revise the text to reflect this requirement.

NW Natural Response

The text has been revised to clarify that the initial notification will go to the National Response Center (800-424-8802) and will include notification to the EPA project manager as soon as possible.

EPA Specific Comment 72

Appendix A – Field Sampling Plan, Section 5 Chemical and Physical Testing, Page 39. PCB Aroclor testing for subsurface samples is acceptable but note that the reporting limit for each Aroclor must be less than 9 micrograms per kilogram (µg/kg). EPA recommends conducting congener analysis for at least the subsurface sample proposed for project area delineation.

NW Natural Response

As shown in Table 4a of Appendix B of the DGWP, the PCB reporting limit for each Aroclor is less than 9 µg/kg. NW Natural maintains that all subsurface PCB analyses will occur via Aroclor testing.

EPA Specific Comment 73

Appendix A – Field Sampling Plan, Section 5.3.1 Depth of Contamination Testing, Page 41. The first bullet point states that: "[if] the bottom sampled depth is a fraction of a foot (e.g. core recovery of 15.3 ft bml), the field team will use best professional judgment to determine whether the additional fraction of sediment is composited with the overlying 1-foot sample or sampled discretely". It is likely that most of the core lengths will not be a round number of feet if the cores are driven to refusal. Develop and include a general rule for this situation. Also note that this topic is more relevant to Section 3.

NW Natural Response

The text has been revised in the referenced section of Appendix A. If the fraction remaining below the bottom of a whole 1-foot interval (e.g., 13 to 14 feet) is greater than 0.5 foot (e.g., 14 to 14.8 feet), then this interval will be archived. If the interval is less than 0.5 foot (e.g., 14 to 14.3 feet), then no archive will be collected due to the sample volume requirements to perform the full ROD Table 21 COCs analyses.

EPA Specific Comment 74

Appendix A – Field Sampling Plan, Section 5.3.3.2 Dredge Material Disposal Suitability Testing, Pages 43-44. Clearly identify the physical characteristics that will be observed visually at specified cure periods.

NW Natural Response

The specific physical characteristics were added to the DGWP.

EPA Specific Comment 75

Appendix A – Field Sampling Plan, Section 5.3.4 Dredge Material Haul Barge Dewatering (Dredge Elutriate Testing), Page 46. Provide a reference for the rapid, small-scale column test.

NW Natural Response

A reference has been added to the DGWP.

EPA Specific Comment 76

Appendix A – Field Sampling Plan, Section 5.3.5 NAPL Mobility Testing, Page 46. The additional parameters being measured as part of NAPL mobility testing should include hydraulic conductivity. Revise as appropriate.

NW Natural Response

The text has been revised to include hydraulic conductivity.

EPA Specific Comment 77

Appendix A – Field Sampling Plan, Section 5.3.6 Biogas Generation Potential Testing, Page 47. Include the rationale for analyzing the 5 to 7 feet interval in the Shallow Region and 6 to 8 feet interval in the Intermediate Region. Also specify the incubation temperature for the microcosm reactors and provide details of the landfill gas analyzer being used to measure biogas composition.

NW Natural Response

The proposed core depth intervals within the shallow and intermediate regions are slightly different for biogas generation potential testing to maintain consistency with the sampling intervals for the other data gaps sampling objectives (e.g., capping demonstration). The data evaluation presented in Appendix F of the DGWP supports the proposed depth intervals. The optimal temperature for methanogenesis is typically in the range of 35 to 45°C. Incubation temperature will be held constant at a value in this range that will be determined empirically through screening tests. A Landtec Biogas 5000 gas analyzer will be used to periodically monitor carbon dioxide, methane, and oxygen concentrations in the produced gas. The gas analyzer will be connected to the gas collection vessel in a closed loop so the gas composition can be measured non-destructively over time.

EPA Specific Comment 78

Appendix A – Field Sampling Plan, Section 5.3.7 Extracted Subsurface NAPL Samples, Page 47. Include wettability in the list of NAPL properties being evaluated. The text states that the TPH measurements from the NAPL extracted from subsurface sediment cores will be used to estimate the amount of TPH in sheen samples. Describe the methodology for applying these results to the sheen samples.

NW Natural Response

Wettability has been added to the list of NAPL properties being evaluated. TPH analysis of NAPL will indicate the percentage of the NAPL mass detectible in a TPH scan. Using this information, sheen TPH data, and the mass of a given sheen net, the total NAPL mass in a given sheen sample can be calculated. For example, if the TPH value for the NAPL is 900,000 milligrams per kilogram, detectible TPH comprises 90% of the NAPL mass. Then the TPH mass collected using sheen nets will be multiplied by (1/0.9) to estimate the total NAPL mass within a given sheen sample.

EPA Specific Comment 79

Appendix A – Field Sampling Plan, Section 5.6 Geotechnical Testing, Page 49. Cite relevant ASTM Standards for all the tests listed in this section.

NW Natural Response

ASTM Standards or other relevant references have been added for the tests listed.

EPA Specific Comment 80

Appendix A – Field Sampling Plan, Attachment A, Gas Ebullition Survey Visual Observations Form. Gas ebullition bubble observations need to be recorded even if there are no associated active sheen blossoms.

NW Natural Response

Bubble observations will be noted even if no associated active sheen blossoms are observed.

EPA Specific Comment 81

Appendix A – Field Sampling Plan, Attachment A, Surface Sediment Field Sample Record. On the sampling form for surface sediment, define what is meant by D.O. for Sediment Color. Additionally, the surface sediment collection form asks for gauge height and the core collection form asks for tide height. Resolve this inconsistency.

NW Natural Response

The surface sediment sample collection and subsurface sediment collection forms have been revised to eliminate D.O. and resolve the referenced inconsistency.

EPA Specific Comment 82

Appendix B – Quality Assurance Project Plan, Approval page, page i. The approval page is unsigned. The final version of the QAPP must include the appropriate approval signatures to document review and concurrence of the contents.

NW Natural Response

The final version of the QAPP will include the appropriate approval signatures.

EPA Specific Comment 83

Appendix B – Quality Assurance Project Plan, Distribution List, page ii. PTS Labs, Inc. is listed. EPA understands this laboratory is closing. Please confirm and update the QAPP and associated tables as needed.

NW Natural Response

The requested information has been added to the QAPP.

EPA Specific Comment 84

Appendix B – Quality Assurance Project Plan, Section 2.1, Project/Task Organization, page 2. Provide a concise organization chart showing the relationships and the lines of communication among all project participants. The project quality assurance (QA) manager position should indicate independence from unit generating data.

NW Natural Response

An organization chart has been added to Appendix B showing the relationships and lines of communication among the project participants.

EPA Specific Comment 85

Appendix B – Quality Assurance Project Plan, Section 2.2, Problem Definition/Background, page 3. This section would benefit from a summary of the work to be performed at the site. The added information should include: decision(s) to be made, actions to be taken, or outcomes expected from the information to be obtained; clearly explain the reason (site background or historical context) for initiating this project; and identify regulatory information, applicable criteria, action limits, etc. necessary to the project. The Data Gaps Work Plan and Appendix A FSP are referenced in the section but a summary of the problem definition should be included in this section of the QAPP.

NW Natural Response

A concise summary of the Problem Definition/Background is already included in Appendix B. The detailed information is in the main body of the DGWP and FSP. The QAPP is an appendix to the DGWP, and its primary purpose is to inform the quality control procedures and analyses during DGWP and FSP implementation, not to be a stand-alone document. Duplication of this information in the same document is unnecessary and leads to the potential for inconsistency. No changes were made to Appendix B based on this comment.

EPA Specific Comment 86

Appendix B – Quality Assurance Project Plan, Section 2.3, Project/Task Description and Schedule, page 4. This section is missing the description of tasks and schedule for work implementation (including start and end dates) and information/figures on geographic locations of field tasks. Reference to specific sections within the Data Gaps Work Plan Appendix A FSP would be acceptable.

NW Natural Response

The requested information has been added to Appendix B.

EPA Specific Comment 87

Appendix B – Quality Assurance Project Plan, Section 3.4.7, Sensitivity, page 13. The section states that data generated from high resolution methods will be reported to estimated detection limits [dioxins/furans and PAHs] which are lower than the laboratory method detection and reporting limits. Since some method detection limits (MDLs) and reporting limits (RLs) are above project cleanup levels shown on Tables 2b, 3 and 5b], the estimated detection limits should be included on the QAPP tables to show that sample results have the potential to achieve the sensitivity requirements needed for decisions to be made resulting from this investigation.

NW Natural Response

Estimated detection limits are dependent on sample and analysis-specific factors. They are calculated at the time of analysis and are typically only reported when analytes are below detection. Since they are not pre-determined, NW Natural cannot include them in the QAPP tables; however, NW Natural does anticipate they will be below MDLs and the ROD Table 17 CULs for samples without significant matrix interferences based on other project experience.

EPA Specific Comment 88

Appendix B – Quality Assurance Project Plan, Section 3.5.1.4 Field Quality Assurance Sampling, page 16. The second paragraph states *"If decontamination procedures are not adequate, additional rinsate blanks will be collected after procedures have been modified."* State how the adequacy of decontamination will be determined, and who will determine if procedures are not adequate. Add clarifying language to explain.

NW Natural Response

The requested information has been added to Appendix B.

EPA Specific Comment 89

Appendix B – Quality Assurance Project Plan, Section 4.1, Field and Laboratory Audits, page 22. Section states that the field performance audits should be conducted by the Field

Coordinator (FC). An audit is defined as an independent review of work. The FC cannot audit work they are responsible for implementing. A more appropriate term would be inspection.

NW Natural Response

The requested information has been added to Appendix B.

EPA Specific Comment 90

Appendix B – Quality Assurance Project Plan, Section 4.1, Field and Laboratory Audits, page 22. The language in this section is conflicting/not clear. The third paragraph states "*a field audit may be scheduled at the discretion of the Project Manager and/or Project QA Manager*". The next sentence states that "*audits will be scheduled to provide coverage and coordination will all ongoing project activities twice during the field sampling program*". The need for an audit should be determined independently by the QA Manager and decided on during the planning phase with additional or new audits scheduled if needed as fieldwork is implemented.

NW Natural Response

The requested information has been added to Appendix B.

EPA Specific Comment 91

Appendix B – Quality Assurance Project Plan, Section 4.1, Field and Laboratory Audits, page 22, third paragraph. Field corrective actions are identified in this section; however, the section does not fully address field audits. Describe each field assessment to be used in the project including the frequency and type. Discuss the information expected and the success criteria (i.e., goals, performance objectives, acceptance criteria specifications, etc.) for each assessment proposed. List the approximate schedule of assessment activities. For any planned self-assessments (utilizing personnel from within the project groups), identify potential participants and their exact relationship within the project organization. Describe how and to whom the results of each assessment shall be reported. Define the scope of authority of the assessors, including stop work orders, and when assessors are authorized to act, but not what kind if any field audits are planned. An audit checklist with details of tasks to be audited can also be referenced or if preferred the checklist can be appended to supplement the text.

NW Natural Response

The text has been revised in the referenced section of Appendix B. Audits may be conducted as specified in Section 4.1 of Appendix B.

EPA Specific Comment 92

Appendix B – Quality Assurance Project Plan, Section 4.1, Field and Laboratory Audits, page 22. For those laboratories that analyze samples, indicate where these facilities have undergone an independent audit as part of a current laboratory accreditation.

NW Natural Response

The requested information has been added to Appendix B.

EPA Specific Comment 93

Appendix B – Quality Assurance Project Plan, Section 4.3, Reports to Management, page 23. Include project QA audit reports to the list of documents in the Reports to Management section.

NW Natural Response

The requested information has been added to Appendix B.

EPA Specific Comment 94

Appendix B – Quality Assurance Project Plan, Section 5, Data Validation, and Usability, page 24. Include the National Functional Guidelines (listed near the bottom of the page) to the first sentence in this section which discusses the validation protocols.

NW Natural Response

The requested information has been added to Appendix B.

EPA Specific Comment 95

Appendix B – Quality Assurance Project Plan, Section 5.1, Data Review, Validation, and Verification, page 24. Include project QA audit reports in the list of documents in Section 4.3, Reports to Management.

NW Natural Response

This comment does not match the referenced section in Appendix B and appears to be a repeat of EPA Specific Comment 93.

EPA Specific Comment 96

Appendix B – Quality Assurance Project Plan, Section 5.2, Validation and Verification Methods, page 24. The first sentence defines validation as including signed entries by field and laboratory technicians on field data sheets and laboratory datasheets respectively; review for completeness and accuracy by the FC and Lab project Manager etc. Suggest replacing the word 'validation' with 'verification'.

NW Natural Response

The requested information has been added to Appendix B.

EPA Specific Comment 97

Appendix B – Quality Assurance Project Plan, Section 5.3, Reconciliation with User Requirements, page 25. In the event that DQOs are not achievable it states that the Project QA

Manager will recommend appropriate modifications. Who will be receiving these recommendations and how will the EPA be informed of DQOs that are not achieved?

NW Natural Response

The requested information has been added to Appendix B.

EPA Specific Comment 98

Appendix B – Quality Assurance Project Plan, References, page 26. Include the full publication citation for the Seepage Induced Consolidation Test that is shown in Table 7.

NW Natural Response

The requested information has been added to Appendix B.

EPA Specific Comment 99

Appendix B – Quality Assurance Project Plan, Tables 2b and 3 - dioxin/furans (Depositional Surface Sediment and Riverbank Boring Soil); and Table 5b – PAHs (Paired Subsurface Porewater Sample Analytes, Methods, and Targeted Reporting Limits). Many MDLs and reporting limits (RLs) are above the Portland Harbor ROD Cleanup Levels. Include some discussion on the impact these elevated limits will have, if any, on data utility. Describe what actions, if any, will be taken to meet the sensitivity requirements for these compounds; if no action will be taken describe why.

NW Natural Response

Dioxin/furan results will be quantified to the estimated detection limit, which are calculated at the instrument using analysis-specific factors and are usually below the MDLs in the absence of matrix interference. The method chosen achieves the lowest detection limits available for this class of compounds. During the spring 2018 interim pre-remedial design data gaps field sampling work performed by NW Natural, transition zone water (TZW) samples were analyzed for PAHs with ROD Table 17 groundwater CULs using the EPA-approved methodologies proposed in the referenced Appendix B table. A very small percentage of the samples were reported as non-detects with MDLs greater than the CULs, and this percentage achieved the data quality objectives (see TEWP Appendix D for more details). None of the TZW samples from 2018 were in contact with sediments containing PTW-NAPL. Alternatively, as discussed in DGWP Sections 3.2.1.1.2 and 3.2.1.1.3, the proposed PAH analyses will only be performed on porewater samples in contact with PTW-NAPL, so concentrations are expected to be higher than those identified in 2018. Therefore, the proposed data should achieve the data quality objectives necessary to support remedial design.

EPA Specific Comment 100

Appendix B – Quality Assurance Project Plan, Table 4e - Nonaqueous Phase Liquid Mobility Testing Analytes, Methods, and Targeted Reporting Limits. EPA understands NW Natural is proposing hydraulic conductivity testing on the core intervals containing NAPL. EPA recommends that representative samples of sediments without NAPL be tested for hydraulic conductivity to develop a reasonable range of values in the project area for use during design. Clarify if vertical hydraulic conductivity testing will also be performed.

NW Natural Response

NW Natural has already deployed ultrasonic seepage meters during two interim data gaps sampling events to measure seepage rates at the site. For more details, see the *Revised NW Natural Proposed Summer 2017 Interim Pre-Remedial Design Data Gaps Field Sampling – Gasco Sediments Site* memorandum, dated August 23, 2017, and the *Revised NW Natural Proposed Spring 2018 Interim Pre-Remedial Design Data Gaps Field Sampling – Gasco Sediments Site* memorandum, dated May 7, 2018. As stated in Appendix C of the TEWP, the empirical data collected to date are sufficient to support cap design modeling and no additional seepage data is required.

EPA Specific Comment 101

Appendix B – Quality Assurance Project Plan, Table 5a - Paired Subsurface Sediment Sample Analytes, Methods, and Targeted Reporting Limits. In the reporting stage of the project, NW Natural should provide results for complete list of VOCs analyzed for in sediment samples using EPA Method 8260C.

NW Natural Response

The text and tables have been revised to include the complete list of VOCs.

EPA Specific Comment 102

Appendix B – Quality Assurance Project Plan, Table 5b - Paired Subsurface Porewater Sample Analytes, Methods, and Targeted Reporting Limits. Add dissolved organic carbon to the suite of analyses for all water samples collected during the data gaps investigations. In the reporting stage of the project, NW Natural should provide results for complete list of VOCs analyzed for in porewater samples using EPA Method 8260C.

NW Natural Response

The text and tables have been revised to add DOC and the complete list of VOCs.

EPA Specific Comment 103

Appendix B – Quality Assurance Project Plan, Table 8 - Field and Laboratory Quality Control Sample Analysis Frequency. Include a Trip Blank for the volatile organic compounds (VOCs) (1 per sample cooler). The Rinsate Blank column can be annotated to include a trip blank. This is required for VOC samples.

NW Natural Response

The requested information has been added to Appendix B.

EPA Specific Comment 104

Appendix C – Health and Safety Plan, Liability Waiver, pages L-1 through L-2. Some of the language, particularly in points 1, 2, and 4, seem to conflict with the Occupational Safety and Health Administration's General Duty Cause and the employer's obligation to provide a workplace free of recognized hazards likely to cause serious physical harm. Also, may appear contradictory to an employee's right to worker's compensation claims for valid, work-related incidents. Consider rewording.

Anchor QEA Response

The liability waiver included in the Anchor QEA HASP is the standard company-wide Liability Waiver developed by the risk management team to be used at all of our sites for non-Anchor QEA employee site visitors. As such, no revisions have been made to the liability waiver based on this comment.

EPA Specific Comment 105

Appendix C – Health and Safety Plan, Site Emergency Procedures, Emergency Response Procedures, pages x and xi. Consider including requirement that field leads check service capabilities of phones in on-river locations, and have a backup (e.g., two-way radio) form of emergency communication available in case of poor service. Vessels on water should always have VHF communication.

Anchor QEA Response

The text has been revised to include daily checks of cell phone service at on-river locations. The sampling vessel has redundant VHF communication capabilities.

EPA Specific Comment 106

Appendix C – Health and Safety Plan, Section 7.4.1.1, Vessel Decontamination Area, page 19. Include that decontamination fluids will be labeled when stored as well (in last sentence of paragraph).

Anchor QEA Response

The text has been revised in the referenced section of the HASP.

EPA Specific Comment 107

Appendix C – Health and Safety Plan, Section 8.5, Handling of Investigation-Derived Waste, page 23. Similar to the above comment, add that the IDW will be labeled when stored.

Anchor QEA Response

The text has been revised in the referenced section of the HASP.

EPA Specific Comment 108

Appendix C – Health and Safety Plan, Section 12.1.9, General Falls and Ladder Usage, page 43. First bullet, modify 6-foot limit of fall protection to 4 feet, which is the newer General Industry standard; states that protection must be implemented when personnel are exposed to unprotected falls of 4 feet or more. The HASP should be checked to maintain compliance with 4-foot standard.

Anchor QEA Response

The text has been revised in the referenced section of the HASP.

EPA Specific Comment 109

Appendix C – Health and Safety Plan, Section 12.1.10, Heavy Equipment Operations, page 43. Second bullet, clarify that it's "…elevated levels 4 feet or greater…" per the new standard.

Anchor QEA Response

The text has been revised in the referenced section of the HASP.

EPA Specific Comment 110

Appendix C – Health and Safety Plan, Section 12.1.12, Drilling with a Hollow Stem Auger or Rotary/Sonic Drill Rig, page 45. In the second bullet it may be more helpful to state that the exclusion zone shall encompass 1.5 times the rig's mast height in any direction, wherever possible, in case of mast failure.

Anchor QEA Response

The text has been revised in the referenced section of the HASP.

EPA Specific Comment 111

Appendix C – Health and Safety Plan, Table 5-1 - Project Job Tasks and Required PPE, page 10-12. It would be helpful to define which Class of American National Standards Institute (ANSI) vest (e.g., Class II) is required at site locations.

Anchor QEA Response

The text has been revised to clarify that a Class I or Class II safety vest will be required for onshore work only.

EPA Specific Comment 112

Appendix C – Health and Safety Plan, Table 5-2 - Project Air Monitoring Requirements, page 13. Clarify if the photoionization detector (PID) lamp of 10.6 eV (instead of 11.2) has already been evaluated and deemed less accurate for use against contaminants. The PID should detect most contaminants listed, except hydrogen cyanide.

Anchor QEA Response

The text has been revised to clarify that a 10.6eV PID lamp will be used. The differences in accuracy between 10.6eV and 11.7eV lamps for the detection of Site VOCs have not been evaluated, but the 10.6eV bulb is suitable the VOCs that could be present at elevated concentrations during sampling based on past sampling activities.

EPA Specific Comment 113

Appendix C – Health and Safety Plan, Table 5-2 - Project Air Monitoring Requirements, page 13. In the dust monitor section, correct measurement columns to both read as 0 to 1 milligram per cubic meter (mg/m3) or 0 to 0.10 mg/mg3. It appears the 0.10 mg/m3 is intended.

Anchor QEA Response

The referenced table has been revised to correct this issue.

EPA Specific Comment 114

Appendix C – Health and Safety Plan, Appendix B Job Safety Analysis Documents, Sediment Sampling, page 2, Ingestion of contaminants. The first bullet states to wear appropriate personal protective equipment (PPE); but it would be instructive to list exactly what that PPE includes. The required PPE list on the front page of the sediment sampling job safety analysis (JSA) leaves some choices as discretionary to employee. This comment also applies to the Active Sheen Blossom Sampling JSA, pg. 2.

Anchor QEA Response

The text has been revised to add additional PPE (i.e., uniform/coveralls, work boots, safety glasses, dust mask, and/or gloves) to both JSAs.

EPA Specific Comment 115

Appendix C – Health and Safety Plan, Appendix B Job Safety Analysis Documents, Sediment Sampling, page 3, Wading. Suggest explicitly stating what types of water depths (e.g., knee height, etc.) or flows to avoid when checking/entering the water. This comment also applies to the Active Sheen Blossom Sampling JSA, page 2.

Anchor QEA Response

The text has been revised to avoid entering the water when depths are greater than waist height and avoid entering the water in areas of high flow or when large floating debris is present.

EPA Specific Comment 116

Addendum dated July 3, 2019, Subsurface Sediment Data Collection Outside the Project Area Page 5. The last sentence states that: "This is the only area identified where subsurface impacts need to be refined proximate to the ROD-identified SMA boundary." Provide detailed information on how this was determined, preferably by including a figure showing subsurface RAL and PTW exceedances. Also explain how this data will be used for the remedial design at Gasco.

Anchor QEA Response

Information regarding how this area was identified for additional subsurface data collection and data uses during remedial design is provided in revised Section 3.1.1.2 and Figures E-1 and E-2 of the newly inserted Appendix E.

EPA Specific Comment 117

Addendum dated July 3, 2019, Figure 3. This figure has some differences from the figure in the DGWP that require explanation. Clarify why some of the sample points are uncolored (while in the DGWP they were colored to indicate PAH concentrations). Also, there are some previous sampling locations shown in the DGWP figure that are not shown in the addendum figure (pairs of samples close to each other) and the text does not explain why some of the samples have labels indicating concentration and sample identification and date while others do not. Provide clarification for these differences.

NW Natural Response

To clarify the EPA comment, Figure 3 in the DGWP Addendum was revised to include colored sample points at all locations. The Figure 3 in the DGWP Addendum inadvertently removed some surface sediment sampling locations where replicate samples were collected (i.e. two side-by-side grabs collected at a single location). These paired samples were returned to Figure 3.

The two clusters of samples downstream in the navigation channel have text boxes to illustrate why no samples are being collected in those areas. The two samples that exceed the navigation channel RAL (GRAB-05 and WR-BC-22) were collected in 1998 and 1997. Since then, two additional rounds of co-located surface samples have been collected that do not exceed the navigation channel RAL, including samples collected in 2018 by the Pre-RD Group. The two DGS-34 samples in the upstream area were collected within 6 months of each other. The first sample did not exceed the navigation channel RAL. However, there was a need to retest bioassays at a subset of locations, including DGS-34, and the second sample collected in 2011 slightly exceeded the navigation channel RAL (1.1 exceedance factor). NW Natural is proposing to collect a three-point composite grab sample co-located with the two previously collected DGS-34 samples to determine if there is an existing RAL exceedance at this location.

EPA Specific Comment 118

Addendum dated July 3, 2019, Figure 9. It is unclear from looking at this figure if the armored riverbank at the Siltronic property extends to the upriver end of the Gasco project area. Revise the figure to show the location of the armored rock at the Siltronic riverbank. If the armor stone does not extend across the entire Siltronic riverbank then additional riverbank borings should be collected in this upriver area.

NW Natural Response

The armored bank at the Siltronic property extends up to the property line shown in Figure 9 and shown in panoramic photographs included as Figure 2.2.2-2 in the Draft EE/CA. The armored extents have been added to Figure 9. See response to EPA Specific Comment 30d regarding riverbank boring collection on the Siltronic property.

Editorial Comments

EPA Editorial Comment 1

Section 3.2.2.1.3 PTW-NAPL Loading to the Cap from Sediment Consolidation, Page 23. The last sentences inaccurately references Section 4.2.3 and should reference Section 3.2.3.

NW Natural Response

The recommended revision has been made to the referenced section in the DGWP.

EPA Editorial Comment 2

Appendix A – Field Sampling Plan, Tables. Provide a table in Appendix A that lists all the samples to be collected at each location, it is inefficient to have this information distributed in multiple tables and sections.

NW Natural Response

The requested summary has been added to Appendix A.

EPA Editorial Comment 3

Appendix A – Field Sampling Plan, Section 3.4.3 Subsurface Sediment Core Logging and Processing Procedures, Page 15. The last sentence of this section refers to holding times twice. If this is an error, update as appropriate (perhaps one should be sample volumes).

NW Natural Response

The requested revision has been made to the referenced section in Appendix A.

EPA Editorial Comment 4

Appendix A – Field Sampling Plan, Section 3.6.2.1 Phase 1 Interim Project Area-Wide Gas Ebullition Observations, Page 21. The first sentence is incomplete, revise as appropriate.

NW Natural Response

The requested revision has been made to the referenced section in Appendix A.

EPA Editorial Comment 5

Appendix A – Field Sampling Plan, Section 3.9.2.3 Geotechnical Sample Processing, Page 29. The first sentence of the second paragraph on this page should be revised to state that: "The filled sample jars or bags and sealed Shelby tubes will be stored at room temperature until delivery to the geotechnical laboratory."

NW Natural Response

The requested revision has been made to the referenced section in Appendix A.

EPA Editorial Comment 6

Appendix A – Field Sampling Plan, Section 5.3.3.1 Toxicity Characteristic Leaching Procedure Testing, Page 43. The second sentence of the final paragraph in this section is incomplete. Revise as necessary.

NW Natural Response

The requested revision has been made to the referenced section in Appendix A.

Attachment A
EPA Comments on NW Natural's Pre-Remedial Design Data Gaps Work Plan – Gasco Sediments Site

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 10
1200 Sixth Avenue, Suite 155
Seattle, WA 98101-3123

SUPERFUND &
EMERGENCY
MANAGEMENT DIVISION

August 12, 2019

Mr. Bob Wyatt *sent via email only*
NW Natural
220 NW 2nd Avenue
Portland OR 97209

Mr. Myron Burr
Siltronic Corporation
7200 NW Front Avenue, M/S 20
Portland, Oregon 97210-3676

Re: Response to Pre-Remedial Design Data Gaps Work Plan, Gasco Sediments Cleanup Action

Dear Sirs:

The Environmental Protection Agency (EPA) reviewed the Pre-Remedial Design Data Gaps Work Plan (DGWP) for the Gasco Sediments Site which was prepared by Anchor QEA, LLC on behalf of NW Natural and dated June 10, 2019. EPA's comments are attached to this letter. Comments were also received from EPA's partners (Oregon Department of Environmental Quality, the Five Tribes[1] and the Yakama Nation) and were incorporated into the EPA comments. Consistent with Section 4 of the Gasco Sediments Site Statement of Work, the Final DGWP is due 60 days from the date of this letter.

Please let me know if you have any questions or concerns at (206) 553-1220 or via email at sheldrake.sean@epa.gov.

Sincerely,

Sean Sheldrake, RPM

Cc:
Lance Peterson, CDM/S via email only
Dana Bayuk, ODEQ

[1] The Five Tribes are the Confederated Tribes of the Grand Ronde Community of Oregon, the Nez Perce Tribe, the Confederated Tribes of Siletz Indians of Oregon, the Confederated Tribes of the Umatilla Indian Reservation, and the Confederated Tribes of the Warm Springs Reservation of Oregon.

EPA Comments on NW Natural's Pre-Remedial Design Data Gaps Work Plan - Gasco Sediments Site Dated June 10, 2019

Comments dated August 9, 2019

The following are United States Environmental Protection Agency (EPA) comments on the *Pre-Remedial Design Data Gaps Work Plan* (DGWP), which was prepared by Anchor QEA on behalf of NW Natural and dated June 10, 2019.

General DGWP Comments

1. NW Natural's Final Revised Pre-Remedial Basis of Design Technical Evaluations Work Plan (TEWP) is dated June 10, 2019 and it is yet to be approved by EPA. Any EPA comments on the TEWP that affect the scope outlined in this Work Plan need to be addressed and incorporated, as necessary. The DGWP is interconnected with the TEWP and the Summary of Final Cap Monitoring Approach – Gasco Sediments Site dated June 25, 2019 (to be incorporated into the TEWP). All three documents need to be cross-checked with each other to provide consistency and protectiveness in remedy design.

2. The DGWP does not provide sufficient information to evaluate the appropriateness of the proposed sampling scope. Examples include the following:
    a. There are several sections in the DGWP which indicate that proposed sample locations have been determined based on previous data interpretations that are not provided in the work plan (e.g. Section 3.2.3.1 discusses geotechnical locations based on existing cross sections).
    b. Section 3.4 of the TEWP indicates the DGWP will present any data gaps identified during review of the Pre-RD Group sampling results. The status of reviewing Pre-RD Group sampling results, and integrating data gaps identified based on this data into the DGWP, is not clear.
    c. Previous approved data collection and analytical approaches are not referenced and not being utilized in all cases for data gaps sampling (e.g., GeoProbe porewater sampling methods, core preservation).

    The Basis of Design Report (BODR) must present a comprehensive summary of existing data with supporting visuals in the context of the refined dredging and capping areas to evaluate whether additional data gaps remain.

3. The ROD Table 17 cleanup levels are identified as the long-term contaminant targets to be achieved by the remedy to meet RAOs. EPA's May 29, 2019 e-mail informs NW Natural that Section 8.2.5 of the ROD requires post-construction verification that additional contaminants of concern (COCs) listed in Table 16 (i.e., "ROD-identified COCs posing potentially unacceptable risk") are addressed by the remedy. EPA recommends that NW Natural evaluate additional COCs during design. NW Natural's May 31, 2019 email response to Sean Sheldrake at EPA indicates that the pre-design data gaps investigations will collect the data necessary to design a remedy consistent with the ROD. The DGWP does not mention additional COCs or Section 8.2.5 of the ROD. Provide clarification regarding the activities NW Natural is undertaking, if any, during data gaps investigations to support evaluations of additional COCs during design. This also applies to text in Section 3.6 of the DGWP.

4. Revise the text to clearly state that if any data gaps associated with the evaluations outlined in the Final TEWP are identified, NW Natural will be required to address those data needs with additional pre-design investigation. Examples of potential data gaps include, but are not limited to, the following:
   a. If it is determined that the remedy design is not appropriately protective of ROD Table 17 COCs and "ROD-identified COCs posing potentially unacceptable risk".
   b. If co-located porewater (total and dissolved concentrations) and sediment samples are not collected and analyzed for the suite of analyses identified for the Spring 2018 porewater/sediment sampling event, including aluminum, barium, iron, magnesium, VPH, and EPH (with dissolved organic carbon for porewater samples). See specific comment 15.
   c. If the entire list of 17 PAHs listed in QAPP tables is not analyzed in all data gap samples.

5. EPA requires both surface and subsurface remedial action level (RAL) or principal threat waste (PTW) exceedances to be evaluated for sediment management area (SMA) delineation. The DGWP does not appropriately acknowledge that subsurface data will be used to refine the project area boundary. EPA's remedial design principles provided as a follow-up to the March 20-21, 2019 workshops should be reviewed for further guidance. Specific comments on DGWP Sections 3.1.1, 3.1.1.2, 3.1.2, Appendix A Section 3.2.1, and the July 3, 2019 addendum discuss specific changes required to address this topic.

6. The DGWP focuses on mobile nonaqueous phase liquid (NAPL) based on the site-specific definition of PTW-NAPL. Confirm or clarify whether figures depicting PTW-NAPL occurrence utilize the site-specific PTW-NAPL definition. The Gasco Statement of Work (SOW) states that "substantial product" will be addressed at the site which includes tar or potentially immobile product in addition to mobile NAPL. Provide clarification on how NW Natural's data gaps sampling and subsequent evaluations will incorporate non-mobile substantial product per the ROD, if encountered in the field.

7. Throughout the DGWP, NW Natural indicates that site-specific principal threat waste – not reliably contained (PTW-NRC) thresholds will be developed for Gasco and implies that EPA has agreed to this approach. This is a mischaracterization of the discussions between EPA and NW Natural that took place on April 4, 2019. Correct the DGWP to indicate that this discussion about PTW-NRC took place but that EPA did not specifically agree to the approach of developing PTW-NRC thresholds. Ultimately, EPA is willing to review NW Natural's proposed approach for determining site-specific PTW-NRC thresholds, and will determine upon that review if the approach is appropriate and acceptable.

8. The DGWP does not clearly indicate whether the capping demonstration and dredging evaluation will be performed throughout the project area, or limited to the areas designated in the Portland Harbor Record of Decision (ROD) for capping or dredging. For example, the proposed data gaps sampling program identifies capping only cores in ROD-identified cap areas, suggesting that a dredging evaluation will not be performed in these areas. The ROD requires that NAPL or PTW that cannot be reliably contained will be dredged unless it is present below the feasible depth limit of excavation technology so capping such areas in lieu of dredging will not be acceptable. Revise the DGWP to incorporate the following:
   a. Document the underlying assumptions built into the data gaps scope of work and fully discuss the data collection objectives in terms of the remedial technologies and the areas being considered for the capping demonstration and/or dredging evaluation.
   b. Revise the dredging evaluation to detail how the limit of excavation will be determined in design.

c. Acknowledge the scenario where dredging is required before capping in areas where PTW-NAPL extends beyond the feasible depth limit of excavation technology and discuss how an appropriate dredge depth is going to be determined.

9. EPA's River Bank Guide needs to be consulted once it is finalized. In addition to evaluating exceedance(s) of RAL (PTW thresholds for riverbank remediation, areas of erodible or non-erodible river banks with contaminant concentrations in soil/sediment greater than cleanup levels (CULs) but less than sitewide RALs may need an action which would be determined through a risk-based decision process. Future design documents should include detailed evaluations identifying riverbanks requiring active remediation.

10. Samples from sediment cores will be selected for analysis to meet a variety of data collection objectives. Perform an assessment of the volumetric material requirements from cores to document adequate sample volume in a core to achieve all of the objectives identified in the DGWP. Include any limitations on NW Natural's ability to fully implement the scope of work for all sample types and analyses in the DGWP.

11. All field deviations from the EPA approved DGWP and Appendix A Field Sampling Plan (FSP) need to be reported for EPA approval as soon as possible and recorded on field deviation forms.

12. Easement authorization from the Department of State Lands (DSL) is discussed only in the context of capping. Revise the text to indicate that DSL will be consulted to determine applicable easement authorization for all remedial activities. The Basis of Design report should document the status and/or outcome of DSL consultations.

13. Clear and concise standard operating procedures (SOPs) should be provided for the field teams so that they can follow through a single task from start to finish. For example, field duplicates are first mentioned in section 3.11.1 of Appendix A but duplicates are not mentioned in the sections of the work plan or field sampling plan which discuss the number of samples or the sample collection process, so field teams collecting samples could inadvertently omit this step. A core processing SOP should clearly identify how cores will be cut for shipping while being held vertically, what is done to prevent sediment loss, and how cross-contamination from the saw will be mitigated.

14. Lack of details and vagueness detracts from the usability of Appendix B – Quality Assurance Project Plan (QAPP). The QAPP is written generically and does not contain sufficient information to satisfy EPA's Guidance for QAPPs[2]. Sufficient detail is needed such that another party could implement the work as intended. Currently, the reader has no frame of reference for what gaps are being investigated, what media are being sampled, and what parameter groups will be analyzed. In addition, the reviewer cannot ascertain if the tables are complete since the media and analytical groups being investigated are unclear. There is some reference to the Work Plan and field sampling plan (FSP) but this causes a lot of searching for information which is not always easily found making the QAPP cumbersome to use. At a minimum, the following items are needed to improve the usability of the document.
    a. In the Introduction add the regulatory framework for the investigation.
    b. In the Introduction section add the problem statement, and project objectives.
    c. Add a summary table showing analytes and media of interest/depth with rationale for collection and how the information obtained will be used to meet the project objectives. Reference this table in the Introduction.
    d. If this information is included in other Work Plan or FSP add a summary or copy for utility.

15. Method modifications are listed on several tests in Appendix B tables; add a note to the tables describing the modifications and explaining the rationale for their usage.

Specific DGWP Comments

1. **Section 2.1.2 Element 3 – Erosion Resistance, Pages 3-5.** Note that caps will also be designed to withstand erosion associated with more frequent floods with higher peak flows more common with climate change, as stated in Record of Decision (ROD) Section 14.2.9.1. Revise the text to discuss that the impact of climate change on stage and river flow will be included in the cap design. Revise the text to include a provision for refinement of the Environmental Fluid Dynamics Code hydrodynamic model grid resolution in the vicinity of the project area, if needed after review of the integrated multibeam bathymetry and light detection and ranging (LiDAR) survey collected in April 2019. The model grid should aim to reproduce key morphological features as apparent in the bathymetry and which can have an impact on the spatial and temporal distribution of currents and water depths (both of which are inputs to the design formulation for the erosion protection layer). In areas to be capped the bathymetry should reflect the post-cap condition for the purposes of cap erosion. Also include references to the design guidance document(s) to be used for the design of the erosion protection layer for river currents, propeller wash, and vessel-generated waves.

2. **Section 2.1.3 Element 4 – Presence and Effect of Debris, Page 5.** Revise the list of information to include debris orientation. Based on the TEWP, low-profile debris with length and width much larger than height dimension may be left in place so in addition to dimensional size, the orientation is also important.

3. **Section 2.1.4 Element 7 – Treatment Requirements, Page 5.** Revise this section to include discussion of how sorption characteristics of the amendment being used will be determined e.g. using sorption characteristics from product vendors, available literature, site-specific sorption testing, etc. Text in

[2] Guidance for Quality Assurance Project Plans, EPA QA/G-5, EPA/240/R-02/009, December 2002

Section 2.1 states that: “The data gaps will be addressed using existing publicly available information.” NW Natural should note that certain proprietary or at least not explicitly publicly available information would be needed to consider treatment requirements. NW Natural should note that the use of treatment amendments can enhance the performance of less thick caps. The evaluations of capping elements should allow necessary flexibility to improve remedy design, including considering and incorporating treatment options.

4. **Section 2.2 Functional Structures Determination, Page 6.** EPA recommends reviewing the methods described in EPA’s January 24, 2014 letter titled *Response to Proposed Methods for the Substantial Product Accessibility Analysis, Gasco Sediments Site* in conjunction with the ROD requirements for functional structures.

5. **Section 2.5 Bathymetry and Topography Survey, Page 7.** The last paragraph states that: “The topography in the direct vicinity of the riverbank has not changed substantially since these survey dates, so NW Natural does not propose an updated survey landside of the top of the riverbank.” Include language documenting what information was relied on to determine that the topography in the direct vicinity of the riverbank has not changed substantially since the 2006 and 2011 topographic surveys.

6. **Section 3 Data Gaps Sampling and Analysis, Page 9.** The text states that: “EPA has indicated that the work can proceed with no additional permitting and that the work can occur outside the generally approved in-water work window of July 1 to October 31, provided that standard best management practices are implemented to avoid adverse effects to fish and wildlife and the aquatic environment.” While EPA agrees, include a citation for the discussions being referenced.

7. **Section 3.1 Interim Project Area Refinement Evaluation, Pages 9-10.** EPA comments on this section are as follows:
   a) Section 3.1 text acknowledges that refinement of the Interim Project Area may be necessary based on the results of surface and subsurface sediment data gaps sampling data. Provide additional clarification regarding data use for project area boundary changes, and acknowledge that additional data collection may be warranted depending on changes to boundaries and implications for technology assignments.
   b) As stated in the general comment regarding substantial product, revise text in this section to provide clarification on how NW Natural’s data gaps sampling and subsequent evaluations will address all substantial product as defined in the SOW. Clarify if the DGWP figures show a PTW-NAPL boundary or if this includes all substantial product. Include a framework for identifying and evaluating non-mobile product or tar observed in samples and its ability to be mobilized.
   c) The PTW-NAPL boundary is defined by the “outer perimeter of the subsurface sampling locations that contain no PTW-NAPL through the complete sampled depth.” Provide information on clean core depths for cores used to delineate PTW-NAPL.
   d) The text states that PTW-highly toxic areas will be identified based on surface sediment data. As discussed during the March 21-22, 2019 EPA workshops, if there is exceedance of PTW-highly toxic thresholds for subsurface sediment then appropriate evaluations will be needed to verify that there is no potential for future exposure to the highly toxic PTW material. Whether or not these

areas will be included in an SMA is dependent on the chemical and physical stability of the buried material.

e) The ROD RALs bullet point states that surface sediment concentrations will be compared against the focused COC RALs. As indicated during the EPA March 20-21, 2019 workshops, surface and subsurface exceedances of RALs are to be used for SMA delineation. Include discussion comparing subsurface RAL exceedances with the project area boundaries.

8. **Section 3.1.1.1.4 Data Density, Page 11.** In order to maintain the data density described in this section and to appropriately refine the project area, at least one additional proposed three-point composite surface sediment sample and one additional sediment core needs to be added in the downriver channelward area outside the current project area boundary shown in Figure 3. Figures 3 and 4 do not show any existing sediment results or proposed samples for this corner.

9. **Section 3.1.1.2 Subsurface Sediment Cores, Page 12.** Add a figure comparing subsurface RAL exceedances with project area boundaries and include an assessment of whether the subsurface data available is sufficient for delineating project area boundaries.

10. **Section 3.1.2 Interim Project Area Refinement Evaluation Data Collection Methods, Subsurface Cores, Page 12.** The text states that: "No chemical analyses will be performed on these cores for the purposes of Interim Project Area refinement." As discussed at the EPA March 20-21, 2019 workshops, both surface and subsurface data is to be used for SMA delineation, so the subsurface cores should be used for project area refinement. The second bullet point proposes a core recovery acceptability criterion of 70%, based on a review of core recoveries from the Interim Project Area. Provide additional detail to clarify how historical core recoveries were used to inform this criterion. The recovery criterion should reflect best coring practices.

11. **Section 3.2 Capping Demonstration Evaluation, Page 13.** Note that the Summary of Final Cap Monitoring Approach – Gasco Sediments Site dated June 25, 2019 developed in coordination with EPA is expected to be implemented, when finalized.

12. **Section 3.2 Capping Demonstration Evaluation, NAPL Reactive Layer, Page 14.** In addition to the three PTW-NAPL transport mechanisms (i.e., advection, gas ebullition-facilitated transport, and sediment consolidation), NW Natural should acknowledge and account for NAPL mobilization during dredging (NAPL flow out of the cut-face) during planning and design. EPA recommends that a range of PTW-NAPL samples be evaluated as part of the advection analysis, including samples exhibiting sheen. Sheen can be a source of contamination at concentrations that warrant consideration for chemical containment during cap design. EPA recommends that samples of water with sheen be collected for analysis across the project area.

13. **Section 3.2.1.1.1 Porewater Concentrations Calculated from Bulk Sediment, Page 14.** EPA comments on this section are as follows:

a) The sampling approach indicates samples within the navigation channel will be collected from -47 feet COP and below. This information appears to assume that material above -47 feet COP will be removed. Confirm or clarify this assumption.

b) The DGWP proposes 2-foot core intervals throughout. Provide clarification regarding whether the resolution of the sampling is sufficient to develop a high-resolution dredge prism as required for the precision dredge methods described in the TEWP.
c) This section states that in the intermediate zone the "…pre-cap elevation is unknown and capping does not depend on the DOC results." Clarify if DOC will be preliminarily used for the dredging elevation and for the capping demonstration, and a representative sample interval will be used once the cap surface elevation is determined.
d) Provide the rationale for selecting 10 to 13-feet as the last sampling interval, and terminating sampling at 13-feet.
e) Confirm whether the method for collecting VOCs will be EPA Method 5035 and subsamples of sediment from each 2-foot interval will be placed in methanol.
f) Provide the rationale for using a 4-foot sampling depth for the cores being collected to measure bulk sediment concentrations.

14. **Section 3.2.1.1.1 Porewater Concentrations Calculated from Bulk Sediment, Navigation Channel, Page 15.** For transparency, provide the rationale behind the assumption of a 3-foot buffer depth for caps in the navigation channel.

15. **Section 3.2.1.1.2 Paired Bulk Subsurface Sediment and Co-Located Porewater Samples to Develop Site-Specific Equilibrium Partitioning Coefficients for VOCs, Page 17.** The text states that: "The proposed locations are identified in areas containing a representative range of VOC bulk sediment and porewater concentrations." Provide clarification for what is meant by representative. If lower concentrations will create problems in developing appropriate partition coefficient values there may be no benefit to sampling the lower VOC concentration areas. Also clarify the basis for using only three VOCs (benzene, trichloroethene (TCE), and vinyl chloride) to support the sampling scope and include information on how the depths for these samples were determined. Appendix E shows figures characterizing VOC concentrations in sediment at various depths. The text in this section states that: "Based on review of the existing subsurface VOC concentrations throughout the Interim Project Area, the paired samples will be collected from 4 to 6 feet below the mudline in the intermediate region and 5 to 7 feet below mudline in the shallow region." Provide clarification on how the review of the existing data was used, including additional information to clarify if the sample depths were selected to target the highest concentrations or some specific range of concentrations. Existing data should be provided in the Basis of Design Report, including the monitoring data for in-water installations. Relevant information should be summarized and discussed for context. For clarification, there are "ROD-identified COCs of lower risk" that are could have partitioning coefficients lower than literature values (e.g. carbon disulfide, isopropylbenzene), and could therefore be considerations for cap design.

    In addition to VOCs, NW Natural should consider collecting and analyzing co-located porewater (total and dissolved concentrations) and sediment samples referenced in this section for the full suite of analyses identified for the Spring 2018 porewater/sediment sampling event, including aluminum, barium, iron, magnesium, VPH, and EPH (with dissolved organic carbon for porewater samples). These data were included in the objectives of the Spring 2018 sampling event but were apparently not collected due to sample volume issues. The Spring 2018 data feed into the evaluations presented in the TEWP that are the basis for the data gaps porewater/sediment sampling and analytical approach in the DGWP. If these data are identified as a data gap that is required to be completed for remedy design, NW Natural will have to address this as part of an additional pre-design investigation.

16. **Section 3.2.1.1.3 Subsurface Porewater Samples in Contact with PTW-NAPL Sediments, Pages 17-18.** The first paragraph of this section discusses the use of porewater samples to define cap model input concentrations. Revise the text in this section to clarify that the dissolved porewater concentrations are to be addressed by these samples and the NAPL product advection is to be addressed separately as described in Section 3.2.2.

17. **Section 3.2.1.1.3 Subsurface Porewater Samples in Contact with PTW-NAPL Sediments, Page 18.** The second paragraph of this section discusses a "representative range of PTW-NAPL characteristics" that will be identified to determine porewater sampling locations. List factors/characteristics that are expected to be evaluated in the field to determine representative sampling locations and discuss what is meant by representative. The text also states that "locations and collection depths will be determined in the field". Include text clarifying when and how this information will be communicated to EPA for approval.

18. **Section 3.2.1.2.1 Porewater Concentrations Calculated from Bulk Sediment, Page 18.** The text indicates that VOC samples will be collected from sediment by immediately placing material into sampling jars using decontaminated bowls and spoons without homogenization. Section 3.4.3 of Appendix A indicates that to minimize volatilization, the sample collection method for VOCs will use a clean "t-bar" sampler to extract and place subsamples from the sampling interval into a pre-labeled container with methanol preservative prior to homogenization. The method described in Section 3.4.3 of Appendix A is the preferred method. Revise the text to confirm the use of this method for collecting all sediment samples for VOC analysis, and that references to EPA Method 5035 in the DGWP are referring to this sampling procedure.

19. **Section 3.2.1.2.2 Paired Bulk Subsurface Sediment and Co-Located Porewater Samples to Develop Site-Specific Equilibrium Partitioning Coefficients for VOCs, Page 19.** EPA comments on this section are as follows:
    a) The text states that: "if there is visual heterogeneity in sediment characteristics, the sample will be collected from the most visually impacted sediment within the sample interval." Discuss what is meant by "most visually impacted", for example, does this refer to potential visual evidence of product or NAPL impacts.
    b) Provide rationale in the text for using a Geoprobe for porewater sampling and not the Trident probe technology used during the Spring 2018 porewater sampling event.
    c) Co-located porewater/sediment samples should be collected as close as possible with a maximum offset of 20 feet which is consistent with the Spring 2018 co-located porewater/sediment sampling.
    d) Co-located porewater/sediment samples should be collected from 4 to 6 feet in the intermediate region and 5 to 7 feet in the shallow region, as stated in Section 3.2.1.1.2, and analyzed for all parameters.

e) The length of the screen through which porewater samples will be collected is referenced as being 2-feet in length in this section, and 4-feet in length in Section 3.5.2 of Appendix A. Resolve this inconsistency.
f) EPA recommends using a conductor casing with a platform (or plate) welded to one end to reduce the potential for surface water/porewater mixing.
g) Include a discussion on the potential for the ceramic filter to influence VOC results.
h) Provide clarification if the use of peristaltic pumps is appropriate for collecting shallow water samples.
i) The representativeness of sediment VOC data increases with the number of subsamples collected from each 2-foot interval. EPA recommends that at least 2-subsamples (one from each foot of the sample interval) be collected from visually homogenous sediment consistent with EPA Method 5035.
j) This section indicates that if there is visual heterogeneity in sediment characteristics, the sample will be collected from the most visually impacted sediment within the sample interval. Revise the text to clarify the approach for collecting samples if there are no visual impacts, but sediment characteristics are heterogeneous.

20. **Section 3.2.2.1.1 PTW-NAPL Loading via Advection, Page 20.** EPA comments on this section are as follows:
    a) The first paragraph states that: "Advection is the flow of continuously connected PTW-NAPL through sediment pore spaces due to hydraulic gradients and PTW-NAPL density/buoyancy forces." EPA understands that this text is referring to advection of saturated product and not dissolved contaminant advection, but this is not clear from this statement. Revise text to clarify as appropriate.
    b) The text for item no. 1 states that large-scale shake tests will be conducted to separate PTW-NAPL from sediment for analysis of fluid properties. While shake tests can be useful in confirming the presence of NAPL, provide the rationale for using shake tests exclusively for separating NAPL since centrifuging sediment samples after shaking would likely provide better separation and larger volumes of PTW-NAPL samples. Also revise the fluid properties being evaluated to include wettability, describe how the separated NAPL will be collected, and discuss the rationale for collecting up to six NAPL samples to determine fluid properties. This also applies to the discussions in Section 3.2.2.2.1.
    c) NW Natural should confirm sample freezing requirements with the laboratory.

21. **Section 3.2.2.1.2 Gas Ebullition-Facilitated Transport of PTW-NAPL, Pages 21-22**. Provide the rationale for the implementation of the high-level scans at low tide and during the late summer. Provide clarification if the additional focused scan to be conducted after the initial high-level scans for ebullition areas will also be conducted at low tide and in late summer. It is possible that additional scans at other time periods will not be able to confirm evidence of gas ebullition or sheen blossoms.

22. **Section 3.2.2.1.2 Gas Ebullition-Facilitated Transport of PTW-NAPL, Page 22, Item 1, first bullet point**. Include text discussing how it will be confirmed that the aerial photography does not miss sheen blossoms that would be visible to the human eye to ensure successful detection.

23. **Section 3.2.2.1.2 Gas Ebullition-Facilitated Transport of PTW-NAPL, Page 22, Item 2, LOE 2**. Provide clarification if the sheen duration can be quantified after sheen formation.

24. **Section 3.2.2.1.2 Gas Ebullition-Facilitated Transport of PTW-NAPL, Page 22, Item 3**. Add text describing how the geochemistry/oxidation reduction potential will be preserved to maintain field conditions and field gas generation rates.

25. **Section 3.2.2.1.2 Gas Ebullition-Facilitated Transport of PTW-NAPL, Page 22**. The text states that: "These sample locations are within the areas where sheen was previously observed and gas ebullition may have occurred." Add a figure showing locations where sheens and gas ebullition are known or suspected to have occurred in the past.

26. **Section 3.2.2.2.1 PTW-NAPL Loading from Advection, Page 23.** The text states that: "Core sections containing the most notable NAPL will be subjected to centrifuge testing with hydraulic gradients 25 times stronger than those that exist in situ to force NAPL to flow from the sample". Clarify whether the hydraulic gradients are 25 times greater than in situ gradients present at the Gasco Sediment Site or 25 times greater than the force of gravity. Also provide information on how long these samples will be centrifuged, how the volume of NAPL extracted and the mass of NAPL remaining in the sample will be quantified, and how the saturation will be determined.

27. **Section 3.2.2.2.2 Gas Ebullition-Facilitated Transport of PTW-NAPL, Page 24**. Add the following details to this section:
    a) The sediment samples for the biogeochemical reactive transport model will be a subset of the locations and intervals from the proposed depth of contamination (DOC) cores. It is unclear if the samples selected for this study will target the most visually impacted sediment samples based on ultraviolet light exposure/photography or other methods will be used to determine appropriate subsamples.
    b) The visual observations and videos/photos discussed in this section are limited to observing and quantifying sheen blossoms. Observations of bubbles being produced due to gas ebullition also need to be recorded, if observed.
    c) A table listing the modeling parameters and the sources of information for each parameter should be provided in the BODR. Also include the names of sites similar to the Gasco Sediment Site where the model has been used.

28. **Section 3.2.3.1 Geotechnical Components Data Gaps Sampling Objectives and Sampling Design, Page 26.** EPA comments on this section are as follows:
    a) The text states that: "Each of the samples will be analyzed for moisture content, Atterberg limits, grain size, specific gravity, dry bulk density, one-dimensional consolidation, direct shear strength, and triaxial shear strength." Consolidation and strength testing should not be conducted on sonic boring samples as the samples are disturbed. In addition, ASTM D1586 cites concerns regarding the influence of vibrations on standard penetration test (SPT) blow counts with sonic drilling. Other more conventional drilling techniques (such as drive and wash) should be considered.

b) The section indicates that geotechnical locations were selected based on cross sections developed in prior work phases. Provide the cross sections with relevant information highlighted for completeness and update Figure 8 to show existing data.
c) Provide the potential alignment for water quality containment engineering controls in the BODR, including a figure showing the conceptual lay-out of the controls.
d) The work plan does not make it clear how the scope of the data gaps geotechnical work will address geotechnical data collection objectives for stability, bearing capacity, and consolidation. Add a table correlating testing results to the components of the geotechnical investigation.
e) NW Natural should consider running CPT logs near selected previously logged sediment borings and/or core locations to evaluate site-specific tool response to sediment types representative of the Interim Project Area.

29. **Section 3.2.3.2 Geotechnical Components Data Collection Methods, Page 26.** The second bullet point states that: "Refusal based on equipment or sampling setup limitations". Sampling setup limitations or physical equipment limitations should not dictate termination depths and contingency plans to make multiple attempts at a boring are required. Drilling methods, equipment and termination depths should be chosen to fulfill the investigation objectives and adequate materials and contingencies should be available to accomplish those objectives. As stated in the comment on Section 3.2.3.1, alternative drilling techniques may need to be considered for collection of geotechnical data.

30. **Section 3.3.1 Riverbank Remedy Evaluation Data Gaps Sampling Objectives and Sampling Design, Pages 27-28.** EPA comments on this section are as follows:
    a) Revise the text to specify the erosion evaluation that NW Natural will perform. Use of the BANCs model is consistent with EPA's riverbank guidance and it was used at the Siltronic site. The model is recommended for the Gasco Site and the data needs of the BANCs model should be met through riverbank data gaps sampling and analysis. If the BANCs model is to be used, provide a table comparing BANCs model input parameters to the information and data available for the riverbank, including the data to be collected during data gaps work.
    b) The section mentions the collection of bulk sediment data to support the riverbank capping demonstration. Include a discussion of the data to be used for evaluating the feasibility of PTW removal, including any handling or management requirements.
    c) Provide the rationale for limiting the bottom depth of borings to be as deep as downgradient sediment sampling locations and the range of distance between proposed riverbank borings and downgradient sediment samples. Include a protocol for the condition where the bottom of the deepest sample is contaminated.
    d) The text states that: "NW Natural understands the heavily armored Siltronic riverbank was constructed as a trapezoid of armor rock". Provide a reference to a document or correspondence that supports this statement. If available, include additional information and as-built cross-sections showing construction representative of the Siltronic riverbank in the DGWP or the TEWP for documentation and completeness.
31. **Section 3.4 Dredging Evaluation, Pages 28-30.** NW Natural proposes collecting samples to further evaluate the lateral and vertical extents of PTW-NAPL, PTW-NRC, PTW-highly toxic threshold, and RAL exceedances in the riverbank. Revise the text in this section to include information on how the vertical and lateral extent of contamination will be defined. Also confirm that a minimum of 22-samples

will be submitted for analysis. Provide clarification for not including information from uplands borings within a lay-back distance of a 5:1 slope.

32. **Section 3.4.2 Dredging Evaluation Data Collection Methods, Page 30.** The second bullet point indicates that in situations where analysis of either of the two bottom depth sample intervals detects concentrations of a parameter that exceeds ROD Table 21 values, the core will be considered unbounded and the DOC will be evaluated using the framework in Section 3.4.3. Section 3.4.3 is missing from the document. The DOC framework also does not appear to be explained in Section 3.4.3 of Appendix A. Revise text as appropriate.

33. **Section 3.5.1.1 Dredge Material Handling and Transport Evaluation, Page 32.** NW Natural characterizes elutriate generation activities as being "short term and intermittent," and indicates that construction will only occur during a portion of the day. NW Natural uses this information to propose acute water quality criteria for discharging elutriate to the Willamette River. Although, daily discharges are projected to be low, actual volumes are currently unknown and volumes for a construction season may be large. Based on available information, discharging elutriate water to the river at concentrations greater than acute water quality criteria is not a preferred option. Consequently, NW Natural should evaluate additional alternatives, including segregating elutriate water for transfer to the uplands for treatment through the Gasco Site water treatment plant. Note that discharges to the river may involve further review by the Oregon DEQ Water Quality Program of elutriate constituents, testing methods, and discharge criteria and may require comparison with chronic water quality criteria. Additionally, the text states that: "Consistent with EPA's Specific Comment 2 in Appendix D, NW Natural will analyze the dredge dewatering elutriate samples for the ROD Table 17 chemicals with groundwater cleanup levels." Revise this list to include all Table 17 COCs with surface water cleanup levels, especially to include dioxin/furan analyses. An appropriate water quality criterion for the dioxin/furans can be discussed with EPA and DEQ.

34. **Section 3.5.1.2 Dredge Material Disposal Suitability Testing, Page 32-33.** Comments regarding the section include the following:
    a) The Gasco Sediments Site SOW states that the single sample per 10,000 cubic yards will be a composite of 3 core locations. Provide the rationale for inconsistencies with the SOW. Sample density does not apply to volumes of sediment that due to regulatory, material handling, and disposal considerations, require separate evaluation. A single composite sample is insufficient to evaluate the volume of sediment potentially containing F002 listed hazardous waste within the Interim Project Area. The sampling program should delineate the volume of F002-impacted sediment to support a contained-in determination. This information is necessary for planning dredging, material handling (e.g., segregation), transport, and disposal.
    b) The section indicates that 22 sediment samples have previously been collected from within the Interim Project Area and tested using the TCLP. The results of the testing are not discussed and/or provided. The information is needed to support NW Natural's proposal to use apply these results to the samples estimated as being needed for data gaps sampling 33-samples total).
    c) The section indicates that the goal of the work is to develop an approach for stabilizing sediment to "pass the paint filter test and meet the minimum structural strength required by the disposal facility." The need for this testing appears to be separate from TCLP analysis of sediment. Consequently, more than 11-samples may need to be collected to provide paint filters and/or

structural strength information. Include sufficient information to show that data gaps sampling will meet project needs in terms of providing sufficient treatability testing results for evaluating amendment effectiveness and determining dosage rates for potential dredge material throughout the Interim Project Area.

35. **Section 3.5.1.2 Dredge Material Disposal Suitability Testing, Page 33.** The footnote states that there will be no testing for reactivity, as stipulated in the SOW, because "NW Natural has no knowledge or reason to believe that the Gasco Sediments Site dredged material is reactive". While this is acceptable to EPA, this may be a disposal facility requirement and NW Natural should confirm with prospective waste disposal facilities before foregoing this analysis. NW Natural also indicates that designation of this characteristic is now based on the generator's knowledge, and the company has no knowledge or reason to believe that the Gasco Sediments Site dredged material is reactive. The reactivity characteristic (D003) applies to waste that meet any one of eight criteria listed in §261.23(a). Document the basis of the company's knowledge in terms of these criteria.

36. **Section 3.5.2.1 Dredge Material Waste Handling and Transport, Page 34.** The text in this section requires a more detailed step-by-step explanation of how the vertically composited sample will be collected. Provide clarification if this will be done after DOC samples have been collected or before the 1-foot core intervals for the DOC cores have been archived.

37. **Section 3.6.1 Additional Analyses Data Quality Objectives and Sampling Design, Page 34.** This section references COCs that have been shown to likely govern remedial design. Revise the text to list these COCs and include the basis for this statement. In addition, explain the term "comprehensive hydrocarbon analysis".

38. **Section 3.6.2 Additional Analyses Data Collection Methods, Page 35.** This section proposes analyzing select samples for stable isotope and bulk elements. The purpose of these analyses is "further characterize hydrocarbon residuals." Provide clarification for the use of this data to inform the project needs.

39. **Section 4.1 Report Contents, Page 36.** The BODR should include figures that display data both laterally and vertically. Data generated during the data gaps investigations, including the sampling results from NW Natural Proposed Spring 2018 Interim Pre-Remedial Design Data Gaps Field Sampling – Gasco Sediments Site memorandum dated April 3, 2018 and the results of previous co-located porewater/sediment analyses, should be submitted to EPA electronically.

40. **Figure 3.** EPA comments related to Figure 3 are as follows:

    a) Provide clarification for why RAL exceedances outside the project area are not included in the natural neighbor interpolation footprints, for example the orange dot near the downstream end of the site in the navigation channel.
    b) Note that the Explanation of Significant Differences (ESD) is not yet finalized, as stated in the figure notes. Therefore, it is acceptable to show these RALs for informational purposes only, but they should not be interpreted as final RALs until the ESD is finalized.
    c) Include a discussion on how the "Gasco Sediments Site Interim Project Area Within the EPA-identified Gasco Project Area" boundary was developed.

41. **Figure 5.** The text associated with the Geotechnical Filter Layer provides information in the context of the layer being necessary. If the geotechnical filter layer is not necessary, the approach to long-term porewater monitoring may be affected. Both the cap design and porewater monitoring approach should be developed in tandem to ensure that the cap modeling assumptions align with future monitoring requirements.

42. **Figure 6.** The locations of the proposed capping only cores appear to be based on the ROD-based technology assignments, suggesting that NW Natural has decided to cap in these areas and will not perform a dredging evaluation. The remainder of the intermediate region appears to consider both dredging and capping technologies. Provide the rationale for not evaluating dredging in the ROD-designated cap areas. Sufficient data should be collected in the intermediate region to fully evaluate both dredging and capping technologies.

43. **Figure 7.** The middle green box states that "some combination of the following tests/methods will be performed." Provide clarification on how it will be determined which methods to use for 'Testing Above NAPL Interval'. Additionally, material type should be considered as a factor in selecting depth intervals containing the highest apparent NAPL saturation with priority given to mobility testing on NAPL-containing intervals in coarser sediments. That said, cores with fine-grained intervals and coarse-grained intervals should be evaluated to develop testing information for a variety of sediment types.

44. **Figure 11.** There appears to be a gap in the coverage of the proposed dewatering cores from between the "Tar Body Removal Action Pilot Cap," upstream of the Gasco and Siltronic site boundary, and out to the navigation channel. Review the figure and add additional cores to fill the gap, as needed.

45. **Figure 13**. This figure identifies locations for analysis of "non site-specific" COCs, however many of these COCs are located and exceed RALs within the project area (e.g., PCBs, DDx). Provide clarification for the term "non-site specific" and retitle the figure as needed.

46. **Appendix A– Field Sampling Plan, Section 3.1 PTW-NAPL Identification, Page 3.** It is unclear how the "full depth of each sediment grab sample" will be inspected for PTW-NAPL. Provide clarification whether the text is referring to the three-point composite sample collected from the grab samples or will the entire depth of the Van Veen grab samples be inspected for PTW-NAPL. The same clarification is also needed for the last paragraph of Section 3.2.2.1.

47. **Appendix A– Field Sampling Plan, Section 3.2.1 Surface Sediment Sampling Plan, Page 4.** Based on the first bullet point it seems that only surface sediment data will be used to refine the project area. As indicated during the March 20-21, 2019 EPA workshops, surface and subsurface exceedances of RALs are to be used for SMA delineation. Revise the text to include the use of subsurface data in addition to surface data for refining the project area. This comment also applies to Section 3.2.2.1.

48. **Appendix A– Field Sampling Plan, Section 3.2.1 Surface Sediment Sampling Plan, Page 4.** The text states that four surface samples will be collected to refine the project area boundary and five samples will be collected to provide additional data densities. These numbers are inconsistent with the sample locations shown in Figure A-2 and listed in Table A-1. Resolve these inconsistencies.

49. **Appendix A– Field Sampling Plan, 3.2.2.1 Interim Project Area Refinement and Additional Surface Sediment Data Density, Page 5.** The text states that: "If no material is recovered after two attempts at a subsample location, the location will be offset to a maximum of a 50-foot radius from the target location." EPA requests that three attempts be made at each subsample location before moving to a 50-foot radius and three attempts should be made at the 50-foot radius alternate location as well.

50. **Appendix A– Field Sampling Plan, Section 3.2.2.2 Early Action Area Pilot Cap Depositional Sediment, Page 6.** The text states that: "Multiple samples that are slightly offset may need to be collected from a single station if the thickness of depositional sediment is insufficient for laboratory analyses of the target analyte list." Revise the text to quantify what is meant by "slightly offset".

51. **Appendix A– Field Sampling Plan, Section 3.3 Riverbank Angled Borings, Page 8.** EPA understands that no riverbank borings are proposed at the Siltronic property due to the trapezoidal armor construction at this bank. See general comment discussing riverbanks.

52. **Appendix A– Field Sampling Plan, Section 3.3.4 Soil Boring Abandonment, Page 10.** The text states that: "For intervals where NAPL is present, the grout slurry will consist of a bentonite/organoclay blend…". Add clarifying text to indicate the basis for determining the presence of NAPL (e.g. based on visual observations in the borehole sample).

53. **Appendix A– Field Sampling Plan, Section 3.4 Subsurface Sediment Sampling, Pages 10-17.** Add a subsection discussing details of the centrifuge test procedures. A description of the centrifuge test is needed which includes details such as test method, volume, durations, etc.

54. **Appendix A– Field Sampling Plan, Section 3.4.2 Subsurface Sediment Collection Methods, Page 12.** This section is lacking details about use of core tube liners, core catchers, etc. Expand the discussion to include such details.

55. **Appendix A– Field Sampling Plan, Section 3.4.2 Subsurface Sediment Collection Methods, Page 13.** Add the following to the list of acceptability criteria for core collection:
    a) Overlying water is present, and the core surface is intact
    b) Core tube is in good condition and not excessively bent

56. **Appendix A– Field Sampling Plan, Section 3.4.2 Subsurface Sediment Collection Methods, Page 13.** The text states that: "The core sections will be stored approximately upright in iced containers in the appropriate orientation until core processing is conducted." If cores are anticipated to be on the vessel for extended periods before being transferred to the processing facility, EPA expects that the cores will be stored upright and on ice aboard the vessel. Revise the text to indicate definitively that the storage procedures will be followed both onboard the vessel and at the processing facility until core processing is performed.

57. **Appendix A– Field Sampling Plan, Section 3.4.5 Shake Test Procedures, Page 17.** Provide justification for the time range provided in bullet 2.e. and explain why a minimum of 5 minutes will allow acceptable separation. Text clarification is also needed on what is meant by "using the same large-scale shake test jar" in bullet point 6 (e.g. the same type of jar or the same jar used for the previous sample).

58. **Appendix A– Field Sampling Plan, Section 3.5.3 Subsurface Porewater Sampling Procedures and Processing, Page 20.** Revise the text to define what is meant by "sufficient recovery" in the tenth item on page 20.

59. **Appendix A– Field Sampling Plan, Section 3.6.1 Gas Ebullition Monitoring Sampling Plan, Phase 2 Gas Ebullition Monitoring, Page 21.** Revise the text as follows: "Focused visual observations (i.e., Line of Evidence 1 described in Section 3.2.2.1.2 of the DGWP) will be concurrently documented by video recordings (i.e., Line of Evidence 2) in areas with observations of gas ebullition and/or active sheen blossoms during Phase 1 gas ebullition monitoring program."

60. **Appendix A– Field Sampling Plan, Section 3.6.2.2 Phase 2 Focused Gas Ebullition Observations, Page 22.** While recording focused observations of apparent gas ebullition or active sheen blossoms, water depth should also be observed and recorded. Revise the text and field form to include these observations.

61. **Appendix A– Field Sampling Plan, Section 3.6.2.2 Phase 2 Focused Gas Ebullition Observations, Page 24.** The second sub-bullet point states that sheen blossom frequency will be recorded "by counting and recording the number of active sheen blossoms that appear during a period in an approximately 10-foot by 10-foot area". Clearly define the time period over which the blossoms will be recorded. Include discussion of a standardized way of determining the 10-foot by 10-foot area so there are not major deviations between different field personnel logging the observations. Additionally, in the third bullet, video of gas ebullition should be recorded for at least 2 minutes.

62. **Appendix A– Field Sampling Plan, Section 3.7.1 Ebullition Sheen Sampling Plan, Page 25.** The text states that: "NW Natural anticipates that between 5 and 10 sheen [sic] active sheen blossom samples will be opportunistically collected…" Note that EPA expects that the 5 to 10 opportunistic sheen samples will be collected at 5 to 10 different locations. Multiple samples collected at the same location will not fulfill this requirement.

63. **Appendix A– Field Sampling Plan, Section 3.8.2 Biogas Generation Potential Sampling Methods, Page 27.** NAPL may also serve as a source of organic matter for biogas generation. Provide clarification if the sample intervals selected will all have presence of PTW-NAPL.

64. **Appendix A– Field Sampling Plan, Section 3.9.2.3 Geotechnical Sample Processing, Page 29.** The last paragraph states that: "Laboratory test assignations will be determined by the field coordinator in consultation with the project geotechnical engineer based on the encountered sediment types." Provide additional information as to what those tests and selection criteria might be. Also, consider replacing "assignations" with "assignments".

65. **Appendix A– Field Sampling Plan, Section 3.9.3 In Situ Penetration Testing, Pages 29-30.** Provide clarification if any pore pressure dissipation tests are planned as part of the cone penetration test scope.

66. **Appendix A– Field Sampling Plan, Section 3.9.3.2 In Situ Penetration Testing Methods, Page 30.** The last bullet point states that: "Because physical samples are not obtained using CPTu or FFP, IDW management and disposal is unnecessary." Consider whether this process will generate decontamination

water or used gloves or other investigation derived waste (IDW). If so, include information on managing these types of IDW.

67. **Appendix A– Field Sampling Plan, Section 3.11.2 Field Blanks, Page 31.** Specify the frequency of rinsate blank and field blank collection.

68. **Appendix A– Field Sampling Plan, Section 3.12.2 Field Quality Assurance/Quality Control Sample Identification, Page 33.** It may be helpful to modify the sample identification described for rinsate blanks to also include identification of the type of equipment that the rinsate blank was collected from. Additionally, the sample numbering scheme of adding 100 to the sample location ID number, so 101 is a duplicate of 01 may not be adequate if the goal is to submit blind samples to the laboratory. Also, there are some station IDs with numbers 100 and up, so this may create confusion using the proposed methodology. For example, PDI-111 is an in-situ penetration test location and is not located near PDI-011 which is a core sampling location, based on figures A-8 and A-11 in the July 3, 2019 addendum. Adjust the sampling identification methodology to include and be consistent with the additional samples that were added in the addendum.

69. **Appendix A – Field Sampling Plan, Section 4.1 Field Documentation, Page 34.** The text states that: "Surface sediment sample, sediment core, gas ebullition observation, and soil boring collection log sheets will be completed for each sampling location (sample log sheets are presented in Attachment A)." Revise the list to include the porewater collection log sheet also provided in Attachment A. Note that any deviations from the approved DGWP and FSP need to be reported to EPA for approval as soon as possible and recorded in field deviation forms.

70. **Appendix A– Field Sampling Plan, Section 4.4.1 Management of Investigation-Derived Waste, Page 37.** This section provides the list of analytes for IDW characterization. Consider including polychlorinated biphenyls (PCBs) for IDW characterization as the disposal contractor will require that information for disposal determination. Include the footnote about reactivity testing from the DGWP (Section 3.5.1.2) in this section for completeness and see the specific comment on Section 3.5.1.2 of the DGWP above.

71. **Appendix A– Field Sampling Plan, Section 4.4.2 Management of Surface Water Sheens, Page 38.** It is unclear which agency the Office of Spill Prevention Section is associated with. Clarify and/or correct the name of this office. In addition to notifying the Office of Spill Prevention, EPA will also be notified as soon as possible. Revise the text to reflect this requirement.

72. **Appendix A– Field Sampling Plan, Section 5 Chemical and Physical Testing, Page 39.** PCB Aroclor testing for subsurface samples is acceptable but note that the reporting limit for each Aroclor must be less than 9 micrograms per kilogram (µg/kg). EPA recommends conducting congener analysis for at least the subsurface sample proposed for project area delineation.

73. **Appendix A– Field Sampling Plan, Section 5.3.1 Depth of Contamination Testing, Page 41.** The first bullet point states that: "[if] the bottom sampled depth is a fraction of a foot (e.g. core recovery of 15.3 ft bml), the field team will use best professional judgment to determine whether the additional fraction of sediment is composited with the overlying 1-foot sample or sampled discretely". It is likely that most of

the core lengths will not be a round number of feet if the cores are driven to refusal. Develop and include a general rule for this situation. Also note that this topic is more relevant to Section 3.

74. **Appendix A– Field Sampling Plan, Section 5.3.3.2 Dredge Material Disposal Suitability Testing, Pages 43-44.** Clearly identify the physical characteristics that will be observed visually at specified cure periods.

75. **Appendix A– Field Sampling Plan, Section 5.3.4 Dredge Material Haul Barge Dewatering (Dredge Elutriate Testing), Page 46.** Provide a reference for the rapid, small-scale column test.

76. **Appendix A– Field Sampling Plan, Section 5.3.5 NAPL Mobility Testing, Page 46.** The additional parameters being measured as part of NAPL mobility testing should include hydraulic conductivity. Revise as appropriate.

77. **Appendix A– Field Sampling Plan, Section 5.3.6 Biogas Generation Potential Testing, Page 47.** Include the rationale for analyzing the 5 to 7 feet interval in the Shallow Region and 6 to 8 feet interval in the Intermediate Region. Also specify the incubation temperature for the microcosm reactors and provide details of the landfill gas analyzer being used to measure biogas composition.

78. **Appendix A– Field Sampling Plan, Section 5.3.7 Extracted Subsurface NAPL Samples, Page 47.** Include wettability in the list of NAPL properties being evaluated. The text states that the TPH measurements from the NAPL extracted from subsurface sediment cores will be used to estimate the amount of TPH in sheen samples. Describe the methodology for applying these results to the sheen samples.

79. **Appendix A– Field Sampling Plan, Section 5.6 Geotechnical Testing, Page 49.** Cite relevant ASTM Standards for all the tests listed in this section.

80. **Appendix A– Field Sampling Plan, Attachment A, Gas Ebullition Survey Visual Observations Form.** Gas ebullition bubble observations need to be recorded even if there are no associated active sheen blossoms.

81. **Appendix A– Field Sampling Plan, Attachment A, Surface Sediment Field Sample Record.** On the sampling form for surface sediment, define what is meant by D.O. for Sediment Color. Additionally, the surface sediment collection form asks for gauge height and the core collection form asks for tide height. Resolve this inconsistency.

82. **Appendix B – Quality Assurance Project Plan, Approval page, page i.** The approval page is unsigned. The final version of the QAPP must include the appropriate approval signatures to document review and concurrence of the contents.

83. **Appendix B – Quality Assurance Project Plan, Distribution List, page ii.** PTS Labs, Inc. is listed. EPA understands this laboratory is closing. Please confirm and update the QAPP and associated tables as needed.

84. **Appendix B – Quality Assurance Project Plan, Section 2.1, Project/Task Organization, page 2.** Provide a concise organization chart showing the relationships and the lines of communication among all project participants. The project quality assurance (QA) manager position should indicate independence from unit generating data.

85. **Appendix B – Quality Assurance Project Plan, Section 2.2, Problem Definition/Background, page 3.** This section would benefit from a summary of the work to be performed at the site. The added information should include: decision(s) to be made, actions to be taken, or outcomes expected from the information to be obtained; clearly explain the reason (site background or historical context) for initiating this project; and identify regulatory information, applicable criteria, action limits, etc. necessary to the project. The Data Gaps Work Plan and Appendix A FSP are referenced in the section but a summary of the problem definition should be included in this section of the QAPP.

86. **Appendix B – Quality Assurance Project Plan, Section 2.3, Project/Task Description and Schedule, page 4.** This section is missing the description of tasks and schedule for work implementation (including start and end dates) and information/figures on geographic locations of field tasks. Reference to specific sections within the Data Gaps Work Plan Appendix A FSP would be acceptable.

87. **Appendix B – Quality Assurance Project Plan, Section 3.4.7, Sensitivity, page 13.** The section states that data generated from high resolution methods will be reported to estimated detection limits [dioxins/furans and PAHs] which are lower than the laboratory method detection and reporting limits. Since some method detection limits (MDLs) and reporting limits (RLs) are above project cleanup levels shown on Tables 2b, 3 and 5b], the estimated detection limits should be included on the QAPP tables to show that sample results have the potential to achieve the sensitivity requirements needed for decisions to be made resulting from this investigation.

88. **Appendix B – Quality Assurance Project Plan, Section 3.5.1.4 Field Quality Assurance Sampling, page 16.** The second paragraph states "*If decontamination procedures are not adequate, additional rinsate blanks will be collected after procedures have been modified.*" State how the adequacy of decontamination will be determined, and who will determine if procedures are not adequate. Add clarifying language to explain.

89. **Appendix B – Quality Assurance Project Plan, Section 4.1, Field and Laboratory Audits, page 22.** Section states that the field performance audits should be conducted by the Field Coordinator (FC). An audit is defined as an independent review of work. The FC cannot audit work they are responsible for implementing. A more appropriate term would be inspection.

90. **Appendix B – Quality Assurance Project Plan, Section 4.1, Field and Laboratory Audits, page 22.** The language in this section is conflicting/not clear. The third paragraph states "*a field audit may be scheduled at the discretion of the Project Manager and/or Project QA Manager*". The next sentence states that "*audits will be scheduled to provide coverage and coordination will all ongoing project*

activities twice during the field sampling program". The need for an audit should be determined independently by the QA Manager and decided on during the planning phase with additional or new audits scheduled if needed as fieldwork is implemented.

91. **Appendix B – Quality Assurance Project Plan, Section 4.1, Field and Laboratory Audits, page 22, third paragraph.** Field corrective actions are identified in this section; however, the section does not fully address field audits. Describe each field assessment to be used in the project including the frequency and type. Discuss the information expected and the success criteria (i.e., goals, performance objectives, acceptance criteria specifications, etc.) for each assessment proposed. List the approximate schedule of assessment activities. For any planned self-assessments (utilizing personnel from within the project groups), identify potential participants and their exact relationship within the project organization. Describe how and to whom the results of each assessment shall be reported. Define the scope of authority of the assessors, including stop work orders, and when assessors are authorized to act, but not what kind if any field audits are planned. An audit checklist with details of tasks to be audited can also be referenced or if preferred the checklist can be appended to supplement the text.

92. **Appendix B – Quality Assurance Project Plan, Section 4.1, Field and Laboratory Audits, page 22.** For those laboratories that analyze samples, indicate where these facilities have undergone an independent audit as part of a current laboratory accreditation.

93. **Appendix B – Quality Assurance Project Plan, Section 4.3, Reports to Management, page 23.** Include project QA audit reports to the list of documents in the Reports to Management section.

94. **Appendix B – Quality Assurance Project Plan, Section 5, Data Validation, and Usability, page 24.** Include the National Functional Guidelines (listed near the bottom of the page) to the first sentence in this section which discusses the validation protocols.

95. **Appendix B – Quality Assurance Project Plan, Section 5.1, Data Review, Validation, and Verification, page 24.** Include project QA audit reports in the list of documents in Section 4.3, Reports to Management.

96. **Appendix B – Quality Assurance Project Plan, Section 5.2, Validation and Verification Methods, page 24.** The first sentence defines validation as including signed entries by field and laboratory technicians on field data sheets and laboratory datasheets respectively; review for completeness and accuracy by the FC and Lab project Manager etc. Suggest replacing the word 'validation' with 'verification'.

97. **Appendix B – Quality Assurance Project Plan, Section 5.3, Reconciliation with User Requirements, page 25.** In the event that DQOs are not achievable it states that the Project QA Manager will recommend appropriate modifications. Who will be receiving these recommendations and how will the EPA be informed of DQOs that are not achieved?

98. **Appendix B – Quality Assurance Project Plan, References, page 26.** Include the full publication citation for the Seepage Induced Consolidation Test that is shown in Table 7.

99. **Appendix B – Quality Assurance Project Plan, Tables 2b and 3 - dioxin/furans (Depositional Surface Sediment and Riverbank Boring Soil); and Table 5b – PAHs (Paired Subsurface Porewater Sample Analytes, Methods, and Targeted Reporting Limits).** Many MDLs and reporting limits (RLs) are above the Portland Harbor ROD Cleanup Levels. Include some discussion on the impact these

elevated limits will have, if any, on data utility. Describe what actions, if any, will be taken to meet the sensitivity requirements for these compounds; if no action will be taken describe why.

100. **Appendix B – Quality Assurance Project Plan, Table 4e - Nonaqueous Phase Liquid Mobility Testing Analytes, Methods, and Targeted Reporting Limits.** EPA understands NW Natural is proposing hydraulic conductivity testing on the core intervals containing NAPL. EPA recommends that representative samples of sediments without NAPL be tested for hydraulic conductivity to develop a reasonable range of values in the project area for use during design. Clarify if vertical hydraulic conductivity testing will also be performed.

101. **Appendix B – Quality Assurance Project Plan, Table 5a - Paired Subsurface Sediment Sample Analytes, Methods, and Targeted Reporting Limits.** In the reporting stage of the project, NW Natural should provide results for complete list of VOCs analyzed for in sediment samples using EPA Method 8260C.

102. **Appendix B – Quality Assurance Project Plan, Table 5b - Paired Subsurface Porewater Sample Analytes, Methods, and Targeted Reporting Limits.** Add dissolved organic carbon to the suite of analyses for all water samples collected during the data gaps investigations. In the reporting stage of the project, NW Natural should provide results for complete list of VOCs analyzed for in porewater samples using EPA Method 8260C.

103. **Appendix B – Quality Assurance Project Plan, Table 8 - Field and Laboratory Quality Control Sample Analysis Frequency.** Include a Trip Blank for the volatile organic compounds (VOCs) (1 per sample cooler). The Rinsate Blank column can be annotated to include a trip blank. This is required for VOC samples.

104. **Appendix C – Health and Safety Plan, Liability Waiver, pages L-1 through L-2.** Some of the language, particularly in points 1, 2, and 4, seem to conflict with the Occupational Safety and Health Administration's General Duty Cause and the employer's obligation to provide a workplace free of recognized hazards likely to cause serious physical harm. Also, may appear contradictory to an employee's right to worker's compensation claims for valid, work-related incidents. Consider rewording.

105. **Appendix C – Health and Safety Plan, Site Emergency Procedures, Emergency Response Procedures, pages x and xi.** Consider including requirement that field leads check service capabilities of phones in on-river locations, and have a backup (e.g., two-way radio) form of emergency communication available in case of poor service. Vessels on water should always have VHF communication.

106. **Appendix C – Health and Safety Plan, Section 7.4.1.1, Vessel Decontamination Area, page 19.** Include that decontamination fluids will be labeled when stored as well (in last sentence of paragraph).

107. **Appendix C – Health and Safety Plan, Section 8.5, Handling of Investigation-Derived Waste, page 23.** Similar to the above comment, add that the IDW will be labeled when stored.

108. **Appendix C – Health and Safety Plan, Section 12.1.9, General Falls and Ladder Usage, page 43.** First bullet, modify 6-foot limit of fall protection to 4 feet, which is the newer General Industry standard; states that protection must be implemented when personnel are exposed to unprotected falls of 4 feet or more. The HASP should be checked to maintain compliance with 4-foot standard.

109. **Appendix C – Health and Safety Plan, Section 12.1.10, Heavy Equipment Operations, page 43.** Second bullet, clarify that it's "…elevated levels 4 feet or greater…" per the new standard.

110. **Appendix C – Health and Safety Plan, Section 12.1.12, Drilling with a Hollow Stem Auger or Rotary/Sonic Drill Rig, page 45.** In the second bullet it may be more helpful to state that the exclusion zone shall encompass 1.5 times the rig's mast height in any direction, wherever possible, in case of mast failure.

111. **Appendix C – Health and Safety Plan, Table 5-1 - Project Job Tasks and Required PPE, page 10-12.** It would be helpful to define which Class of American National Standards Institute (ANSI) vest (e.g., Class II) is required at site locations.

112. **Appendix C – Health and Safety Plan, Table 5-2 - Project Air Monitoring Requirements, page 13.** Clarify if the photoionization detector (PID) lamp of 10.6 eV (instead of 11.2) has already been evaluated and deemed less accurate for use against contaminants. The PID should detect most contaminants listed, except hydrogen cyanide.

113. **Appendix C – Health and Safety Plan, Table 5-2 - Project Air Monitoring Requirements, page 13.** In the dust monitor section, correct measurement columns to both read as 0 to 1 milligram per cubic meter (mg/m3) or 0 to 0.10 mg/mg3. It appears the 0.10 mg/m3 is intended.

114. **Appendix C – Health and Safety Plan, Appendix B Job Safety Analysis Documents, Sediment Sampling, page 2, Ingestion of contaminants.** The first bullet states to wear appropriate personal protective equipment (PPE); but it would be instructive to list exactly what that PPE includes. The required PPE list on the front page of the sediment sampling job safety analysis (JSA) leaves some choices as discretionary to employee. This comment also applies to the Active Sheen Blossom Sampling JSA, pg. 2.

115. **Appendix C – Health and Safety Plan, Appendix B Job Safety Analysis Documents, Sediment Sampling, page 3, Wading.** Suggest explicitly stating what types of water depths (e.g., knee height, etc.) or flows to avoid when checking/entering the water. This comment also applies to the Active Sheen Blossom Sampling JSA, page 2.

116. **Addendum dated July 3, 2019, Subsurface Sediment Data Collection Outside the Project Area Page 5.** The last sentence states that: "This is the only area identified where subsurface impacts need to be refined proximate to the ROD-identified SMA boundary." Provide detailed information on how this was determined, preferably by including a figure showing subsurface RAL and PTW exceedances. Also explain how this data will be used for the remedial design at Gasco.

117. **Addendum dated July 3, 2019, Figure 3.** This figure has some differences from the figure in the DGWP that require explanation. Clarify why some of the sample points are uncolored (while in the DGWP they were colored to indicate PAH concentrations). Also, there are some previous sampling locations shown in the DGWP figure that are not shown in the addendum figure (pairs of samples close to each other) and the text does not explain why some of the samples have labels indicating concentration and sample identification and date while others do not. Provide clarification for these differences.

118. **Addendum dated July 3, 2019, Figure 9.** It is unclear from looking at this figure if the armored riverbank at the Siltronic property extends to the upriver end of the Gasco project area. Revise the figure to show the location of the armored rock at the Siltronic riverbank. If the armor stone does not extend across the entire Siltronic riverbank then additional riverbank borings should be collected in this upriver area.

Editorial Comments

1. **Section 3.2.2.1.3 PTW-NAPL Loading to the Cap from Sediment Consolidation, Page 23.** The last sentences inaccurately references Section 4.2.3 and should reference Section 3.2.3.

2. **Appendix A – Field Sampling Plan, Tables.** Provide a table in Appendix A that lists all the samples to be collected at each location, it is inefficient to have this information distributed in multiple tables and sections.

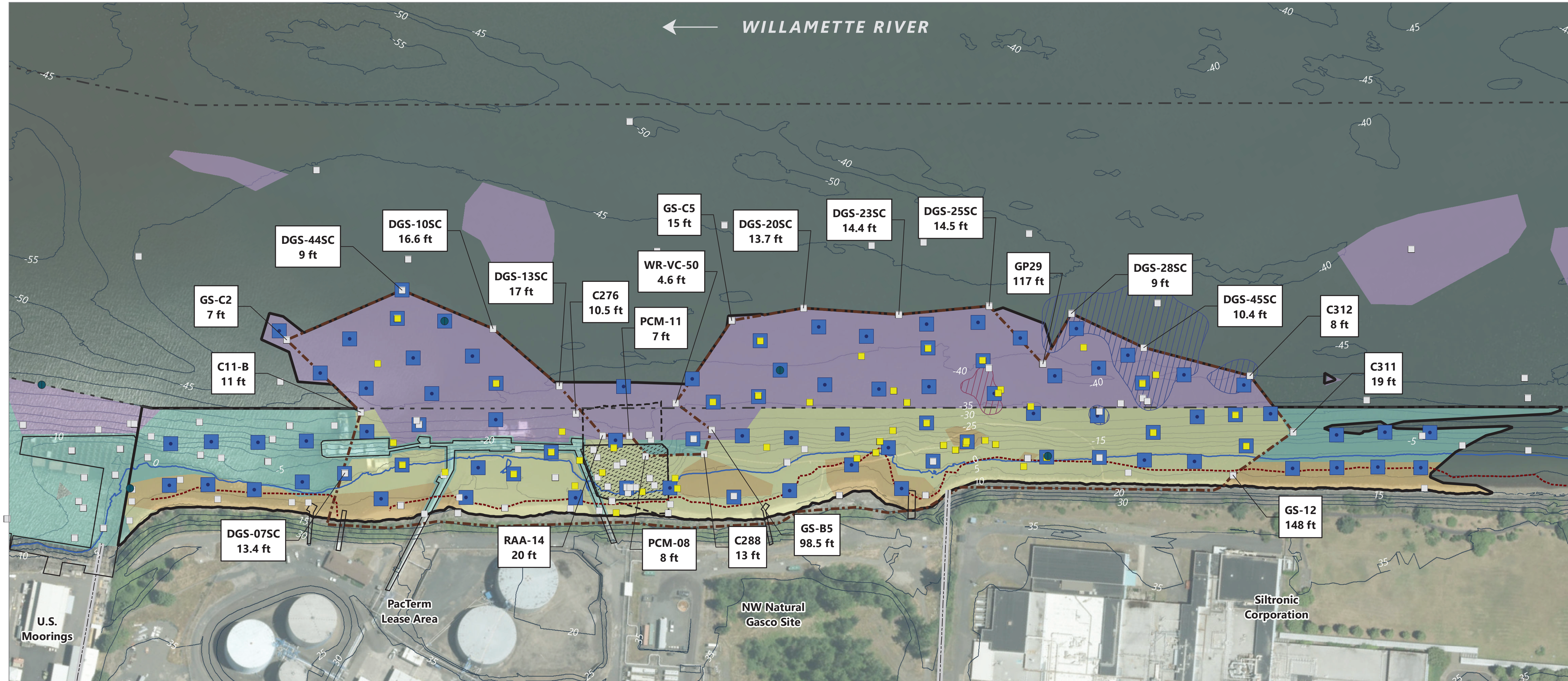
3. **Appendix A– Field Sampling Plan, Section 3.4.3 Subsurface Sediment Core Logging and Processing Procedures, Page 15.** The last sentence of this section refers to holding times twice. If this is an error, update as appropriate (perhaps one should be sample volumes).

4. **Appendix A– Field Sampling Plan, Section 3.6.2.1 Phase 1 Interim Project Area-Wide Gas Ebullition Observations, Page 21.** The first sentence is incomplete, revise as appropriate.

5. **Appendix A– Field Sampling Plan, Section 3.9.2.3 Geotechnical Sample Processing, Page 29.** The first sentence of the second paragraph on this page should be revised to state that: "The filled sample jars or bags and sealed Shelby tubes will be stored at room temperature until delivery to the geotechnical laboratory."

6. **Appendix A– Field Sampling Plan, Section 5.3.3.1 Toxicity Characteristic Leaching Procedure Testing, Page 43.** The second sentence of the final paragraph in this section is incomplete. Revise as necessary.

Attachment B
Recovery Depth of Cores on PTW-NAPL Perimeter



LEGEND:

- Navigation Channel
- Structures
- Property Line
- Tar Body Removal Action Area (RAPP, Anchor 2005)
- Tar Body Removal Action Pilot Cap
- PTW-NAPL Boundary
- Elevation (feet COP)
- +1.1 feet COP[1]
- Approximate Riprap Boundary[2]
- ROD-Identified SMAs (EPA 2017) Included in the Gasco Sediment Site Interim Project Area[2]

ROD SMA Technology[3]

- Cap
- Dredge
- Dredge in Nav-FMD
- Dredge with Cap
- 2010 Transition Zone Water Vinyl Chloride Area 1 Boundary (Anchor QEA 2012)[4]
- Area 2 – Detected CVOCs in TZW and One Subsurface Sediment Location[5]
- Pre-RD Group Harborwide Monitoring Subsurface Sample Location (AECOM and Geosyntec 2018a)
- Existing Cores with Previously Observed PTW-NAPL
- Existing Subsurface Sample Location
- Proposed DOC and Capping Demonstration Core Locations[6]

C311 ← **Core ID**
19 ft ← **Bottom Recovery Depth (feet)**

NOTES:

1. ROD-identified -2 Feet Columbia River Datum Shallow Region elevation threshold converted to City of Portland vertical datum.
2. Estimated from side scan sonar survey conducted by Blue Water Engineering April 2011.
3. All depicted SMA technology and PTW contours taken from the Portland Harbor Superfund Site Record of Decision (2017) without application of the EPA Explanation of Significant Differences (ESD; EPA 2018), which is not yet finalized.
4. Boundary taken from Draft Engineering Evaluation/Cost Analysis, Appendix A, Figure 4.2. Transition zone water screening level exceedances of cis-1,2-dichloroethene identified within this vinyl chloride boundary.
5. Boundary taken from Gasco Sediments Site Statement of Work, Figure 1 (EPA 2009).
6. Each core will be visually logged through the full recovery depth for the presence of PTW-NAPL using the site-specific definition
7. Bathymetry surveyed by DEA 2018. Topography surveyed by Geometrix 2011.
8. Arrow indicates direction of flow of river.
9. Horizontal datum is NAD83 (HARN 91) Oregon State Plane North, International Feet.
10. Vertical datum is City of Portland (COP), Feet.
11. Aerial imagery from City of Portland 2018.

0 200
Feet

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Figure 1
Recovery Depth of Cores on PTW-NAPL Perimeter
Response-to-Comment Memorandum Attachment B
Gasco Sediments Cleanup Action

Attachment C
Gasco OU Interim Feasibility Study
Geotechnical Cross Sections

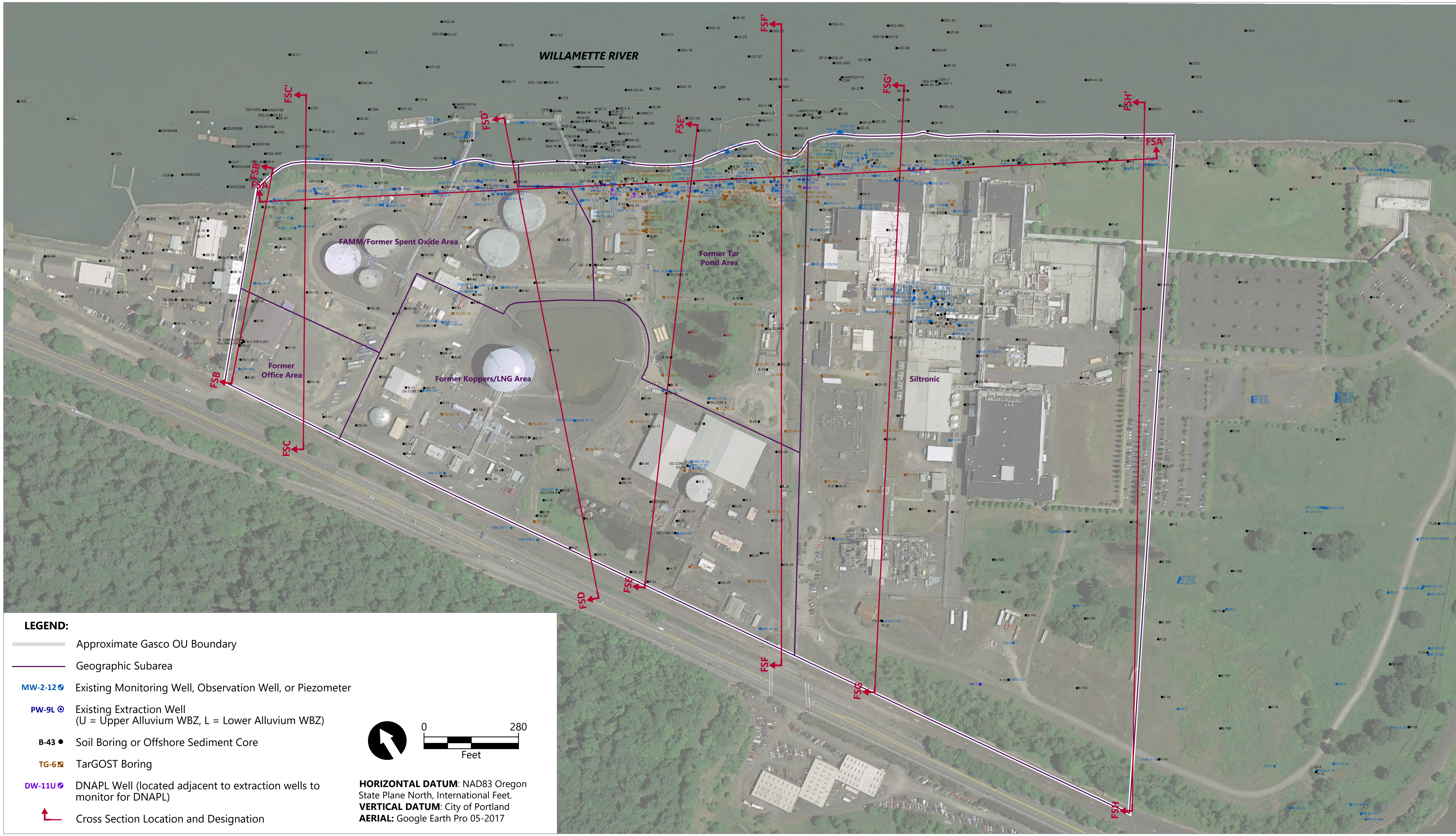

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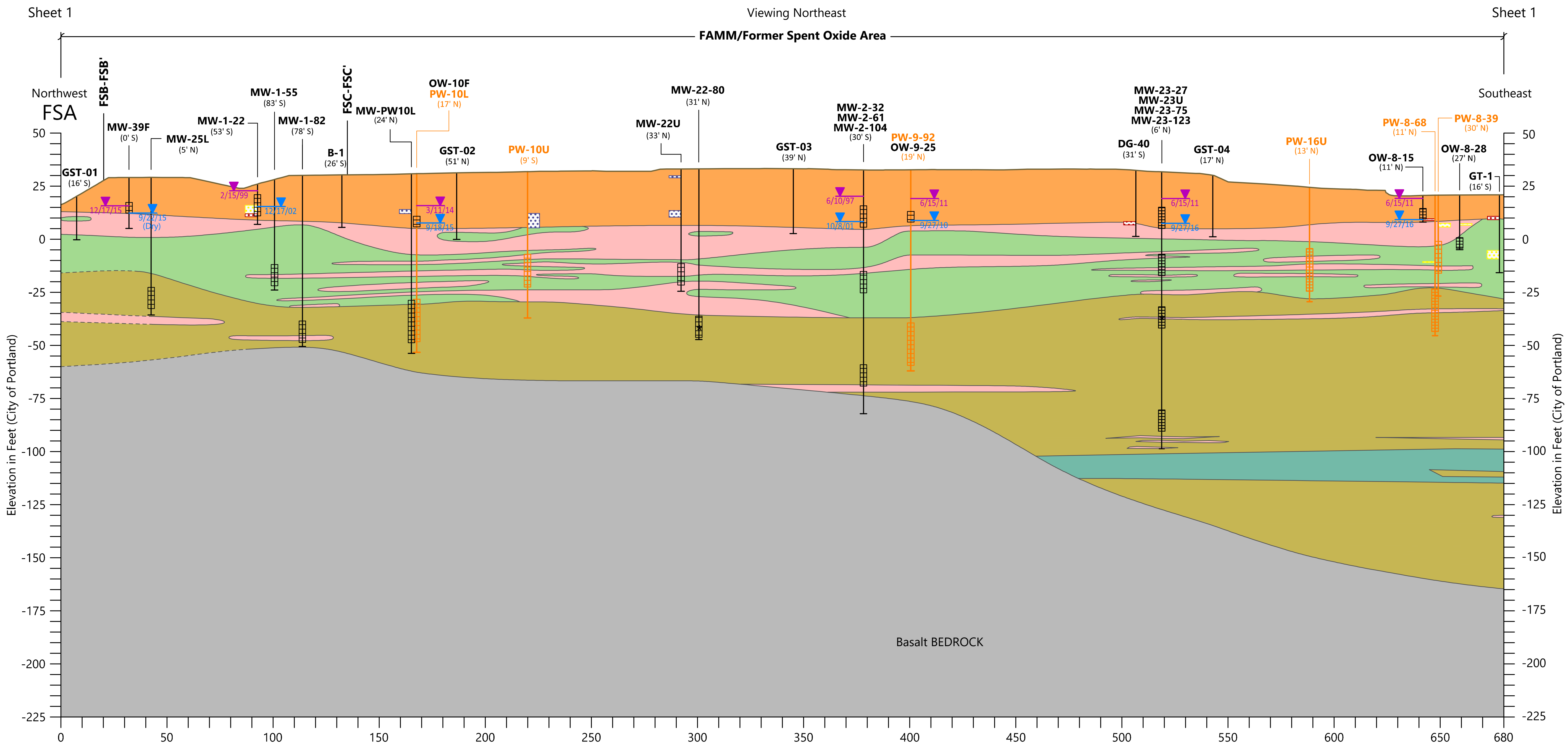
Figure 3-3a
Monitoring Well and Cross Section Location Map

Interim Feasibility Study
Gasco OU



Horizontal Distance in Feet
No Vertical Exaggeration

0 50 Feet

LEGEND:

Fill WBZ – Fill composed of gravel, silt, sand, metal, brick, and concrete debris

Upper Alluvium WBZ – Primarily fine- to-medium-grained SAND and SILTY-SAND interbedded with thin silt and sandy-silt layers

Primarily SILT and SANDY-SILT interbedded with thin sand and silty-sand layers

Lower Alluvium WBZ – Primarily medium-grained SAND with generally less than 5% fines

Alluvial GRAVEL, sandy gravel, gravelly sand, and gravelly silt

Aquitard – Primarily SILT and SANDY-SILT interbedded with thin sand and silty-sand layers

Basalt Bedrock

Existing Ground Surface

Geologic Contact (dashed where inferred)

7/15/16 Highest Recorded Fill WBZ Groundwater Elevation, 1995-2016

7/15/16 Lowest Recorded Fill WBZ Groundwater Elevation, 1995-2016

P-46 — Boring ID

(4.6' N) — Offset Distance in Feet

Existing Extraction Well

Existing Well or Piezometer

— Oil or Mixed Oil and Tar within a Soil Matrix

— Solid Tar or Tar Mixed within a Soil Matrix

— Soil Matrix Containing Sheen

— Well Screen

NOTES:

1. Residual and potentially mobile oil are not differentiated on this figure.
2. Inferred WBZ and Basalt unit contacts interpolated from geologic unit structural maps created for the site hydrogeologic model.
3. Groundwater elevations from the flood of 1996 were omitted as an extreme event.
4. Zones containing MGP residuals depicted on this figure are highly generalized. Within the depicted zones, the distribution of MGP materials is highly heterogenous and discontinuous in three dimensions within the stratigraphy and soil matrix.

* Control well

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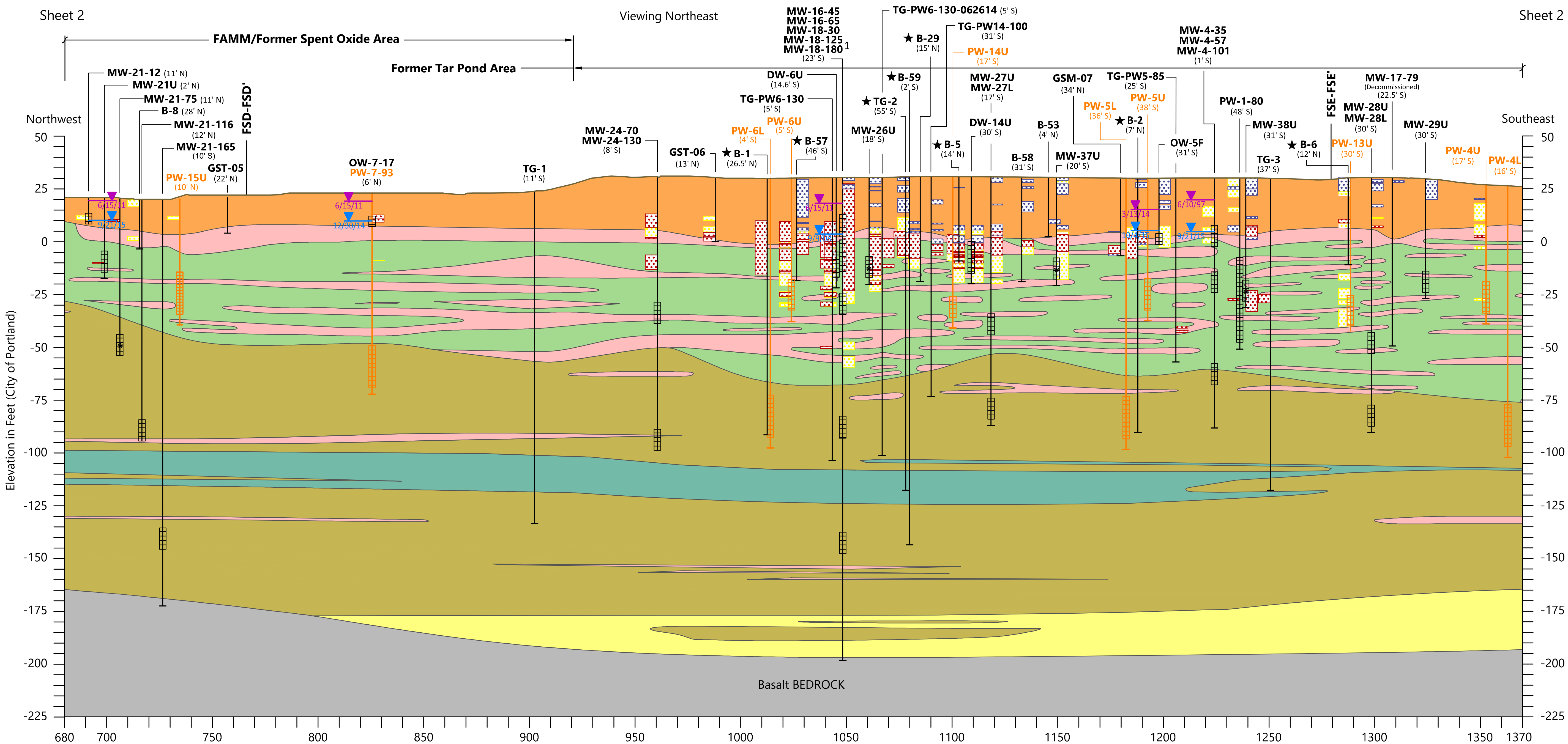
Figure 3-3b
Cross Section FSA-FSA' – Sheet 1 of 4

Interim Feasibility Study
Gasco OU



Horizontal Distance in Feet
No Vertical Exaggeration

0 50 Feet

LEGEND:

- **Fill WBZ** – Fill composed of gravel, silt, sand, metal, brick, and concrete debris
- **Upper Alluvium WBZ** – Primarily fine- to-medium-grained SAND and SILTY-SAND interbedded with thin silt and sandy-silt layers
- Primarily SILT and SANDY-SILT interbedded with thin sand and silty-sand layers
- **Lower Alluvium WBZ** – Primarily medium-grained SAND with generally less than 5% fines
- Alluvial GRAVEL, sandy gravel, gravelly sand, and gravelly silt
- **Aquitard** – Primarily SILT and SANDY-SILT interbedded with thin sand and silty-sand layers
- Basalt Bedrock
- Existing Ground Surface
- Geologic Contact (dashed where inferred)
- 7/15/16 Highest Recorded Fill WBZ Groundwater Elevation, 1995-2016
- 7/15/16 Lowest Recorded Fill WBZ Groundwater Elevation, 1995-2016

P-46 — Boring ID
(4.6' N) — Offset Distance in Feet

- Oil or Mixed Oil and Tar within a Soil Matrix
- Solid Tar or Tar Mixed within a Soil Matrix
- Soil Matrix Containing Sheen
- Existing Extraction Well / Existing Well or Piezometer — Well Screen

NOTES:

1. Residual and potentially mobile oil are not differentiated on this figure.
2. Inferred WBZ and Basalt unit contacts interpolated from geologic unit structural maps created for the site hydrogeologic model.
3. Groundwater elevations from the flood of 1996 were omitted as an extreme event.
4. Zones containing MGP residuals depicted on this figure are highly generalized. Within the depicted zones, the distribution of MGP materials is highly heterogenous and discontinuous in three dimensions within the stratigraphy and soil matrix.

* Control well

★ Not used for geologic interpretation

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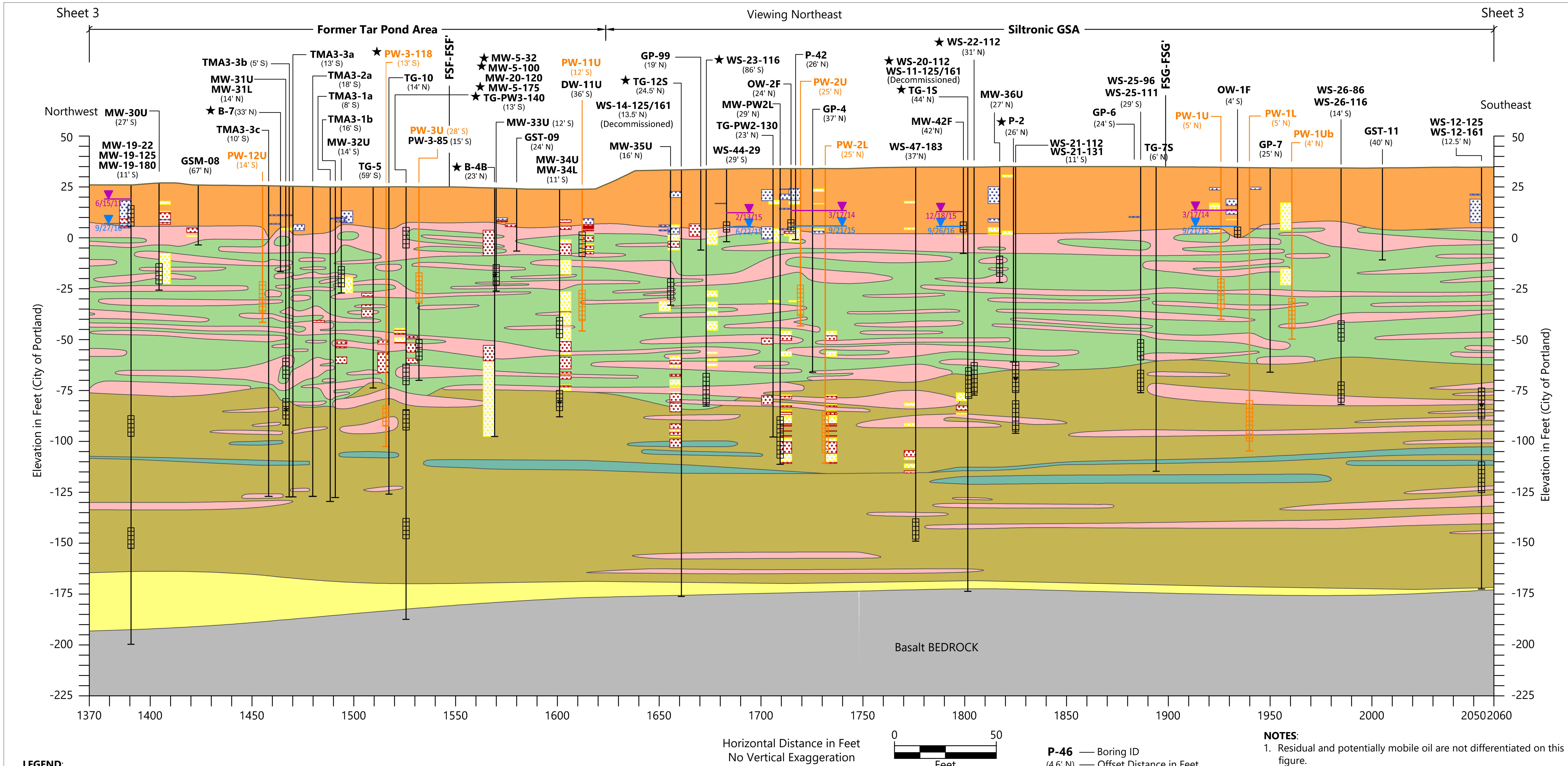
Figure 3-3b
Cross Section FSA-FSA' – Sheet 2 of 4

Interim Feasibility Study
Gasco OU



LEGEND:

- **Fill WBZ** – Fill composed of gravel, silt, sand, metal, brick, and concrete debris
- **Upper Alluvium WBZ** – Primarily fine- to-medium-grained SAND and SILTY-SAND interbedded with thin silt and sandy-silt layers
- Primarily SILT and SANDY-SILT interbedded with thin sand and silty-sand layers
- **Lower Alluvium WBZ** – Primarily medium-grained SAND with generally less than 5% fines
- Alluvial GRAVEL, sandy gravel, gravelly sand, and gravelly silt
- **Aquitard** – Primarily SILT and SANDY-SILT interbedded with thin sand and silty-sand layers
- Basalt Bedrock
- Existing Ground Surface
- Geologic Contact (dashed where inferred)
- 7/15/16 Highest Recorded Fill WBZ Groundwater Elevation, 1995-2016
- 7/15/16 Lowest Recorded Fill WBZ Groundwater Elevation, 1995-2016

P-46 — Boring ID
(4.6' N) — Offset Distance in Feet

Existing Extraction Well
Existing Well or Piezometer

- Oil or Mixed Oil and Tar within a Soil Matrix
- Solid Tar or Tar Mixed within a Soil Matrix
- Soil Matrix Containing Sheen
- Well Screen

NOTES:

1. Residual and potentially mobile oil are not differentiated on this figure.
2. Inferred WBZ and Basalt unit contacts interpolated from geologic unit structural maps created for the site hydrogeologic model.
3. Groundwater elevations from the flood of 1996 were omitted as an extreme event.
4. Zones containing MGP residuals depicted on this figure are highly generalized. Within the depicted zones, the distribution of MGP materials is highly heterogenous and discontinuous in three dimensions within the stratigraphy and soil matrix.

* Control well
★ Not used for geologic interpretation

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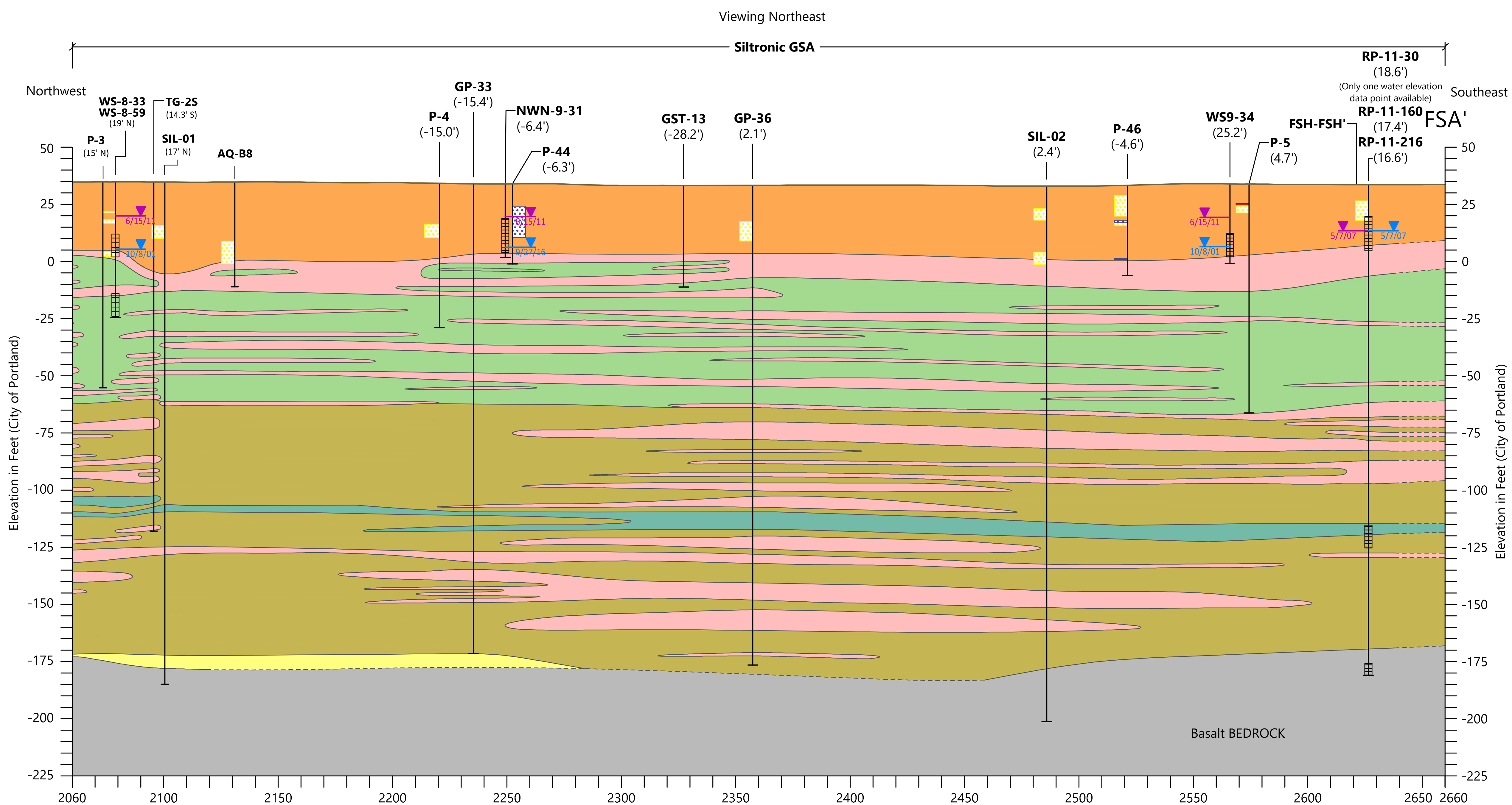
Figure 3-3b
Cross Section FSA-FSA' – Sheet 3 of 4

Interim Feasibility Study
Gasco OU



LEGEND:

	Fill WBZ – Fill composed of gravel, silt, sand, metal, brick, and concrete debris
	Upper Alluvium WBZ – Primarily fine- to-medium-grained SAND and SILTY-SAND interbedded with thin silt and sandy-silt layers
	Primarily SILT and SANDY-SILT interbedded with thin sand and silty-sand layers
	Lower Alluvium WBZ – Primarily medium-grained SAND with generally less than 5% fines
	Alluvial GRAVEL, sandy gravel, gravelly sand, and gravelly silt
	Aquitard – Primarily SILT and SANDY-SILT interbedded with thin sand and silty-sand layers
	Basalt Bedrock

Existing Ground Surface

Geologic Contact (dashed where inferred)

7/15/16 Highest Recorded Fill WBZ Groundwater Elevation, 1995-2016

7/15/16 Lowest Recorded Fill WBZ Groundwater Elevation, 1995-2016

P-46 — Boring ID
(4.6' N) — Offset Distance in Feet

Existing Extraction Well
Existing Well or Piezometer

— Oil or Mixed Oil and Tar within a Soil Matrix
— Solid Tar or Tar Mixed within a Soil Matrix
— Soil Matrix Containing Sheen
— Well Screen

NOTES:

1. Residual and potentially mobile oil are not differentiated on this figure.
2. Inferred WBZ and Basalt unit contacts interpolated from geologic unit structural maps created for the site hydrogeologic model.
3. Groundwater elevations from the flood of 1996 were omitted as an extreme event.
4. Zones containing MGP residuals depicted on this figure are highly generalized. Within the depicted zones, the distribution of MGP materials is highly heterogenous and discontinuous in three dimensions within the stratigraphy and soil matrix.

* Control well
★ Not used for geologic interpretation

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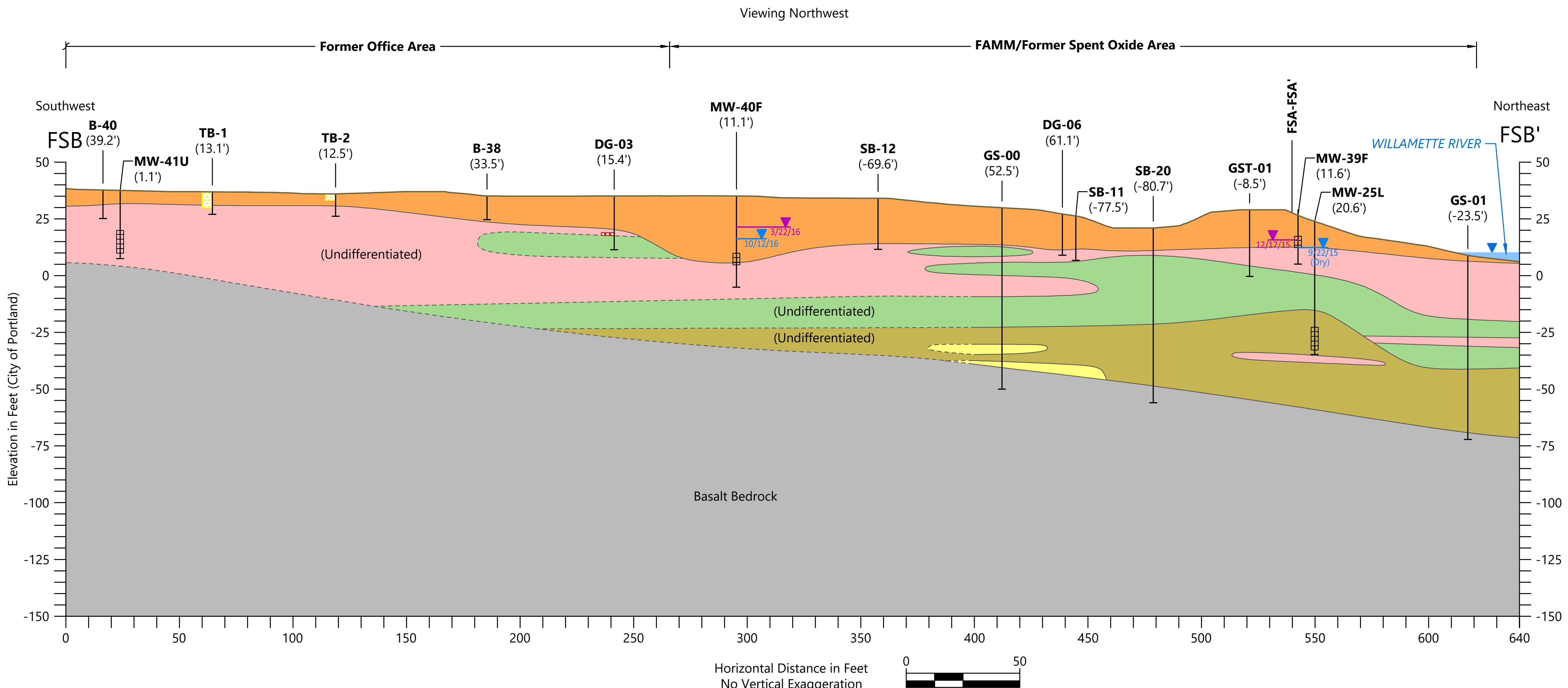
Figure 3-3b
Cross Section FSA-FSA' – Sheet 4 of 4

Interim Feasibility Study
Gasco OU



LEGEND:

Fill WBZ – Fill composed of gravel, silt, sand, metal, brick, and concrete debris

Upper Alluvium WBZ – Primarily fine- to-medium-grained SAND and SILTY-SAND interbedded with thin silt and sandy-silt layers

Primarily SILT and SANDY-SILT interbedded with thin sand and silty-sand layers

Lower Alluvium WBZ – Primarily medium-grained SAND with generally less than 5% fines

Alluvial GRAVEL, sandy gravel, gravelly sand, and gravelly silt

Aquitard – Primarily SILT and SANDY-SILT interbedded with thin sand and silty-sand layers

Basalt Bedrock

Existing Ground Surface

Geologic Contact (dashed where inferred)

7/15/16 Highest Recorded Fill WBZ Groundwater Elevation, 1995-2016

7/15/16 Lowest Recorded Fill WBZ Groundwater Elevation, 1995-2016

P-46 — Boring ID
(4.6' N) — Offset Distance in Feet

Existing Extraction Well
Existing Well or Piezometer

— Oil or Mixed Oil and Tar within a Soil Matrix
— Solid Tar or Tar Mixed within a Soil Matrix
— Soil Matrix Containing Sheen
— Well Screen

NOTES:
1. Inferred WBZ and Basalt unit contacts interpolated from geologic unit structural maps created for the site hydrogeologic model.
2. Groundwater elevations from the flood of 1996 were omitted as an extreme event.
3. Zones containing MGP residuals depicted on this figure are highly generalized. Within the depicted zones, the distribution of MGP materials is highly heterogenous and discontinuous in three dimensions within the stratigraphy and soil matrix.

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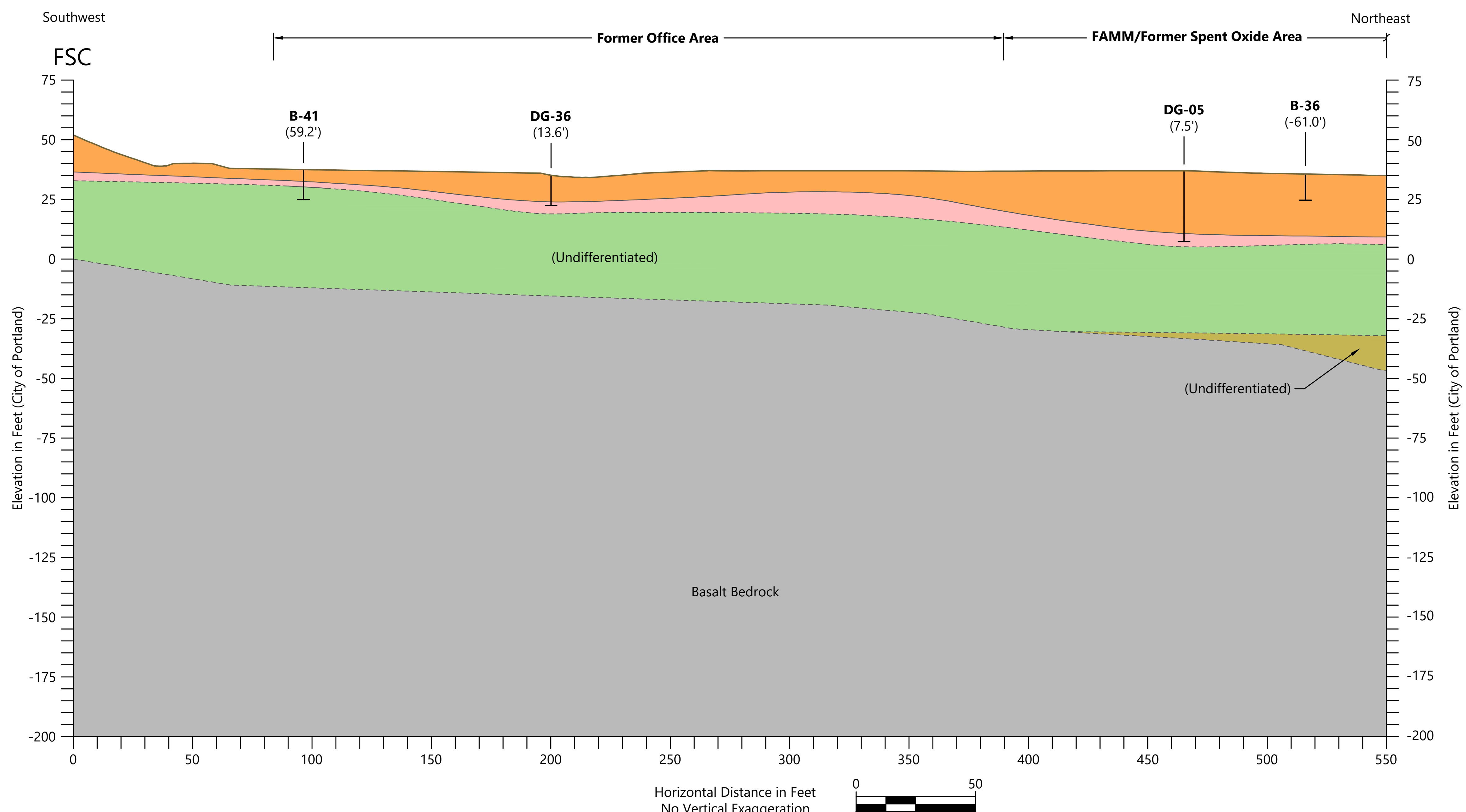
Figure 3-3c
Cross Section FSB-FSB'

Interim Feasibility Study
Gasco OU

Sheet 1 | Viewing Northwest | Sheet 1



LEGEND:

- **Fill WBZ** – Fill composed of gravel, silt, sand, metal, brick, and concrete debris
- **Upper Alluvium WBZ** – Primarily fine- to-medium-grained SAND and SILTY-SAND interbedded with thin silt and sandy-silt layers
- Primarily SILT and SANDY-SILT interbedded with thin sand and silty-sand layers
- **Lower Alluvium WBZ** – Primarily medium-grained SAND with generally less than 5% fines
- Alluvial GRAVEL, sandy gravel, gravelly sand, and gravelly silt
- **Aquitard** – Primarily SILT and SANDY-SILT interbedded with thin sand and silty-sand layers
- Basalt Bedrock
- Existing Ground Surface
- Geologic Contact (dashed where inferred)
- 7/15/16 Highest Recorded Fill WBZ Groundwater Elevation, 1995-2016
- 7/15/16 Lowest Recorded Fill WBZ Groundwater Elevation, 1995-2016
- **P-46** — Boring ID
- (4.6' N) — Offset Distance in Feet
- — Oil or Mixed Oil and Tar within a Soil Matrix
- — Solid Tar or Tar Mixed within a Soil Matrix
- — Soil Matrix Containing Sheen
- — Well Screen
- Existing Extraction Well
- Existing Well or Piezometer

NOTES:

1. Residual and potentially mobile oil are not differentiated on this figure.
2. Inferred WBZ and Basalt unit contacts interpolated from geologic unit structural maps created for the site hydrogeologic model.
3. Groundwater elevations from the flood of 1996 were omitted as an extreme event.
4. Zones containing MGP residuals depicted on this figure are highly generalized. Within the depicted zones, the distribution of MGP materials is highly heterogenous and discontinuous in three dimensions within the stratigraphy and soil matrix.

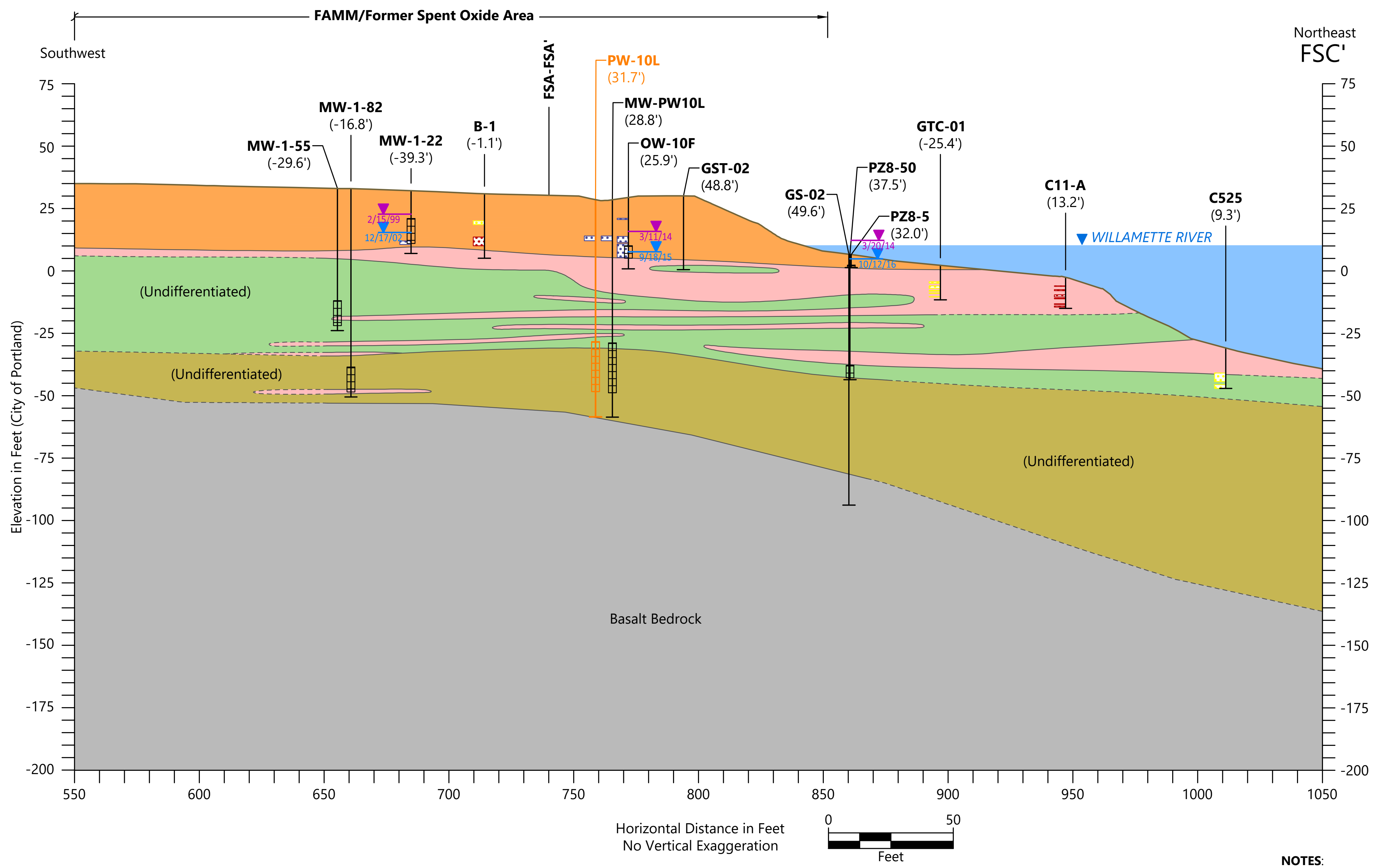
Figure 3-3d
Cross Section FSC-FSC' – Sheet 1 of 2

Interim Feasibility Study
Gasco OU

Sheet 2

Viewing Northwest

Sheet 2



LEGEND:

Fill WBZ – Fill composed of gravel, silt, sand, metal, brick, and concrete debris

Upper Alluvium WBZ – Primarily fine- to-medium-grained SAND and SILTY-SAND interbedded with thin silt and sandy-silt layers

Primarily SILT and SANDY-SILT interbedded with thin sand and silty-sand layers

Lower Alluvium WBZ – Primarily medium-grained SAND with generally less than 5% fines

Alluvial GRAVEL, sandy gravel, gravelly sand, and gravelly silt

Aquitard – Primarily SILT and SANDY-SILT interbedded with thin sand and silty-sand layers

Basalt Bedrock

Existing Ground Surface

Geologic Contact (dashed where inferred)

7/15/16 Highest Recorded Fill WBZ Groundwater Elevation, 1995-2016

7/15/16 Lowest Recorded Fill WBZ Groundwater Elevation, 1995-2016

P-46 — Boring ID

(4.6' N) — Offset Distance in Feet

Existing Extraction Well

Existing Well or Piezometer

— Oil or Mixed Oil and Tar within a Soil Matrix

— Solid Tar or Tar Mixed within a Soil Matrix

— Soil Matrix Containing Sheen

— Well Screen

NOTES:

1. Residual and potentially mobile oil are not differentiated on this figure.
2. Inferred WBZ and Basalt unit contacts interpolated from geologic unit structural maps created for the site hydrogeologic model.
3. Groundwater elevations from the flood of 1996 were omitted as an extreme event.
4. Zones containing MGP residuals depicted on this figure are highly generalized. Within the depicted zones, the distribution of MGP materials is highly heterogenous and discontinuous in three dimensions within the stratigraphy and soil matrix.

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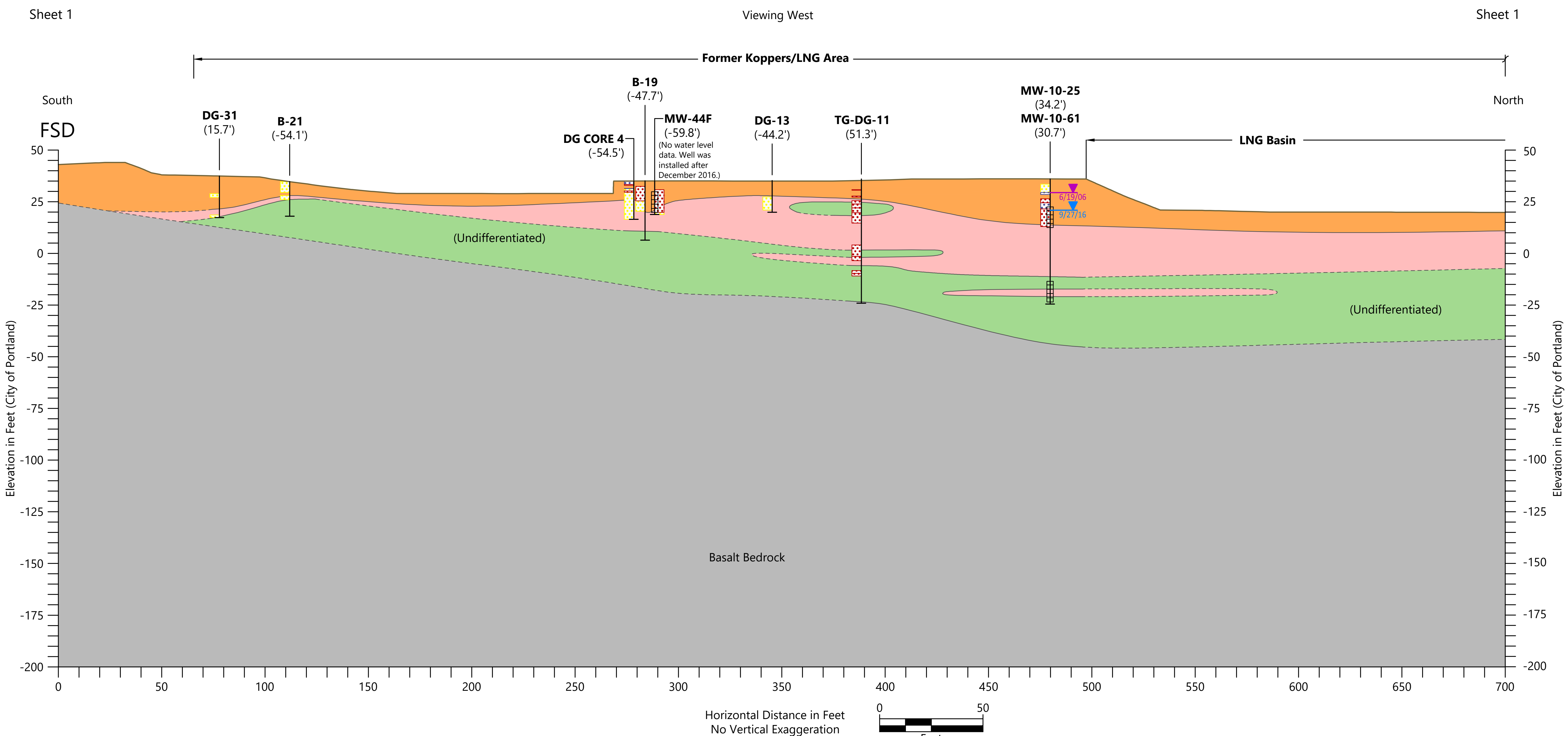
Figure 3-3d
Cross Section FSC-FSC' – Sheet 2 of 2

Interim Feasibility Study
Gasco OU



LEGEND:

Fill WBZ – Fill composed of gravel, silt, sand, metal, brick, and concrete debris

Upper Alluvium WBZ – Primarily fine- to-medium-grained SAND and SILTY-SAND interbedded with thin silt and sandy-silt layers

Primarily SILT and SANDY-SILT interbedded with thin sand and silty-sand layers

Lower Alluvium WBZ – Primarily medium-grained SAND with generally less than 5% fines

Alluvial GRAVEL, sandy gravel, gravelly sand, and gravelly silt

Aquitard – Primarily SILT and SANDY-SILT interbedded with thin sand and silty-sand layers

Basalt Bedrock

Existing Ground Surface

Geologic Contact (dashed where inferred)

7/15/16 Highest Recorded Fill WBZ Groundwater Elevation, 1995-2016

7/15/16 Lowest Recorded Fill WBZ Groundwater Elevation, 1995-2016

P-46 — Boring ID

(4.6' N) — Offset Distance in Feet

— Oil or Mixed Oil and Tar within a Soil Matrix

— Solid Tar or Tar Mixed within a Soil Matrix

— Soil Matrix Containing Sheen

— Well Screen

Existing Extraction Well

Existing Well or Piezometer

NOTES:

1. Residual and potentially mobile oil are not differentiated on this figure.
2. Inferred WBZ and Basalt unit contacts interpolated from geologic unit structural maps created for the site hydrogeologic model.
3. Groundwater elevations from the flood of 1996 were omitted as an extreme event.
4. Zones containing MGP residuals depicted on this figure are highly generalized. Within the depicted zones, the distribution of MGP materials is highly heterogenous and discontinuous in three dimensions within the stratigraphy and soil matrix.

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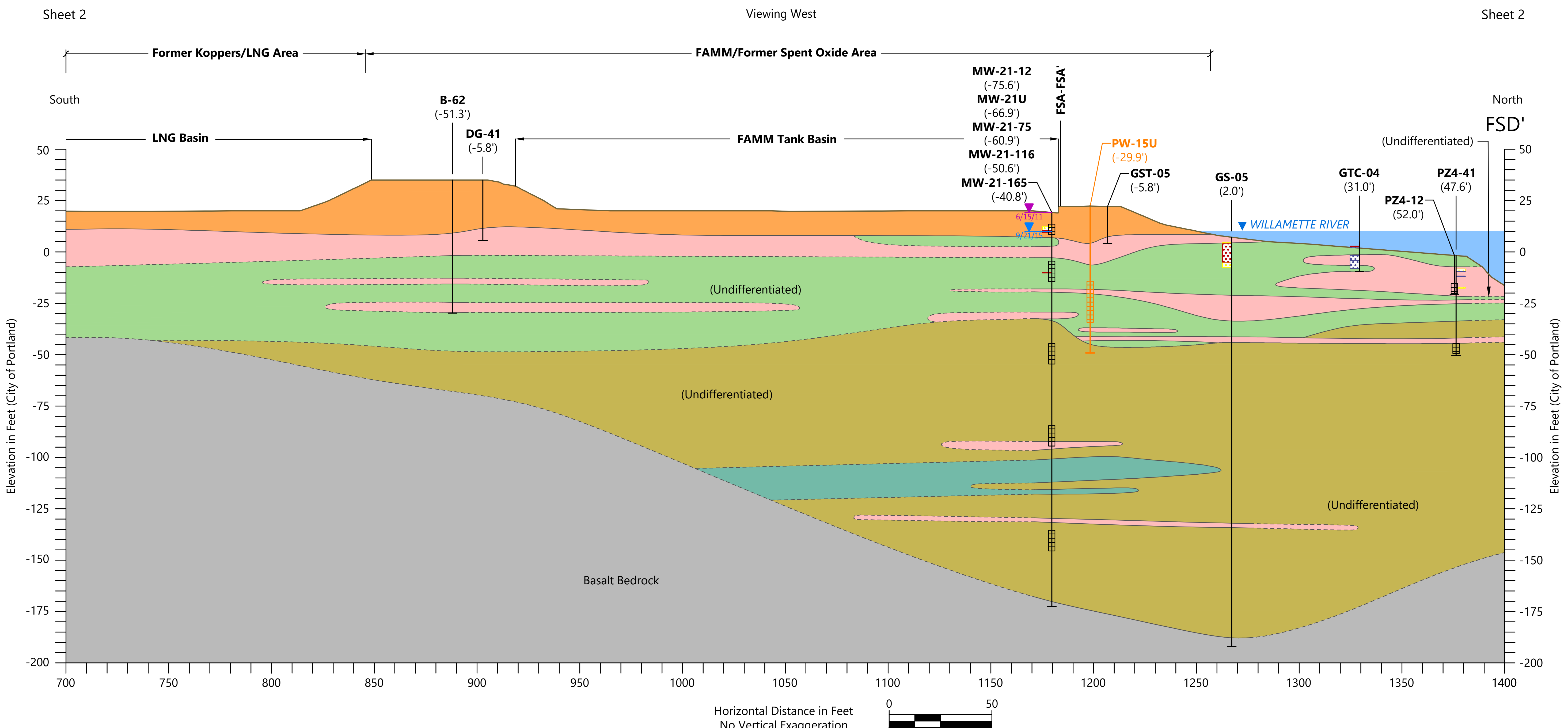
Figure 3-3e
Cross Section FSD-FSD' – Sheet 1 of 2
Interim Feasibility Study
Gasco OU



LEGEND:

- **Fill WBZ** – Fill composed of gravel, silt, sand, metal, brick, and concrete debris
- **Upper Alluvium WBZ** – Primarily fine- to-medium-grained SAND and SILTY-SAND interbedded with thin silt and sandy-silt layers
- Primarily SILT and SANDY-SILT interbedded with thin sand and silty-sand layers
- **Lower Alluvium WBZ** – Primarily medium-grained SAND with generally less than 5% fines
- Alluvial GRAVEL, sandy gravel, gravelly sand, and gravelly silt
- **Aquitard** – Primarily SILT and SANDY-SILT interbedded with thin sand and silty-sand layers
- Basalt Bedrock
- Existing Ground Surface
- Geologic Contact (dashed where inferred)
- 7/15/16 Highest Recorded Fill WBZ Groundwater Elevation, 1995-2016
- 7/15/16 Lowest Recorded Fill WBZ Groundwater Elevation, 1995-2016
- **P-46** — Boring ID
- (4.6' N) — Offset Distance in Feet
- Existing Extraction Well
- Existing Well or Piezometer
- Tar Interval
- Oil or Mixed Oil and Tar Interval
- Sheen Interval
- Well Screen

NOTES:

1. Residual and potentially mobile oil are not differentiated on this figure.
2. Inferred WBZ and Basalt unit contacts interpolated from geologic unit structural maps created for the site hydrogeologic model.
3. Groundwater elevations from the flood of 1996 were omitted as an extreme event.
4. Zones containing MGP residuals depicted on this figure are highly generalized. Within the depicted zones, the distribution of MGP materials is highly heterogenous and discontinuous in three dimensions within the stratigraphy and soil matrix.

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Figure 3-3e
Cross Section FSD-FSD' – Sheet 2 of 2

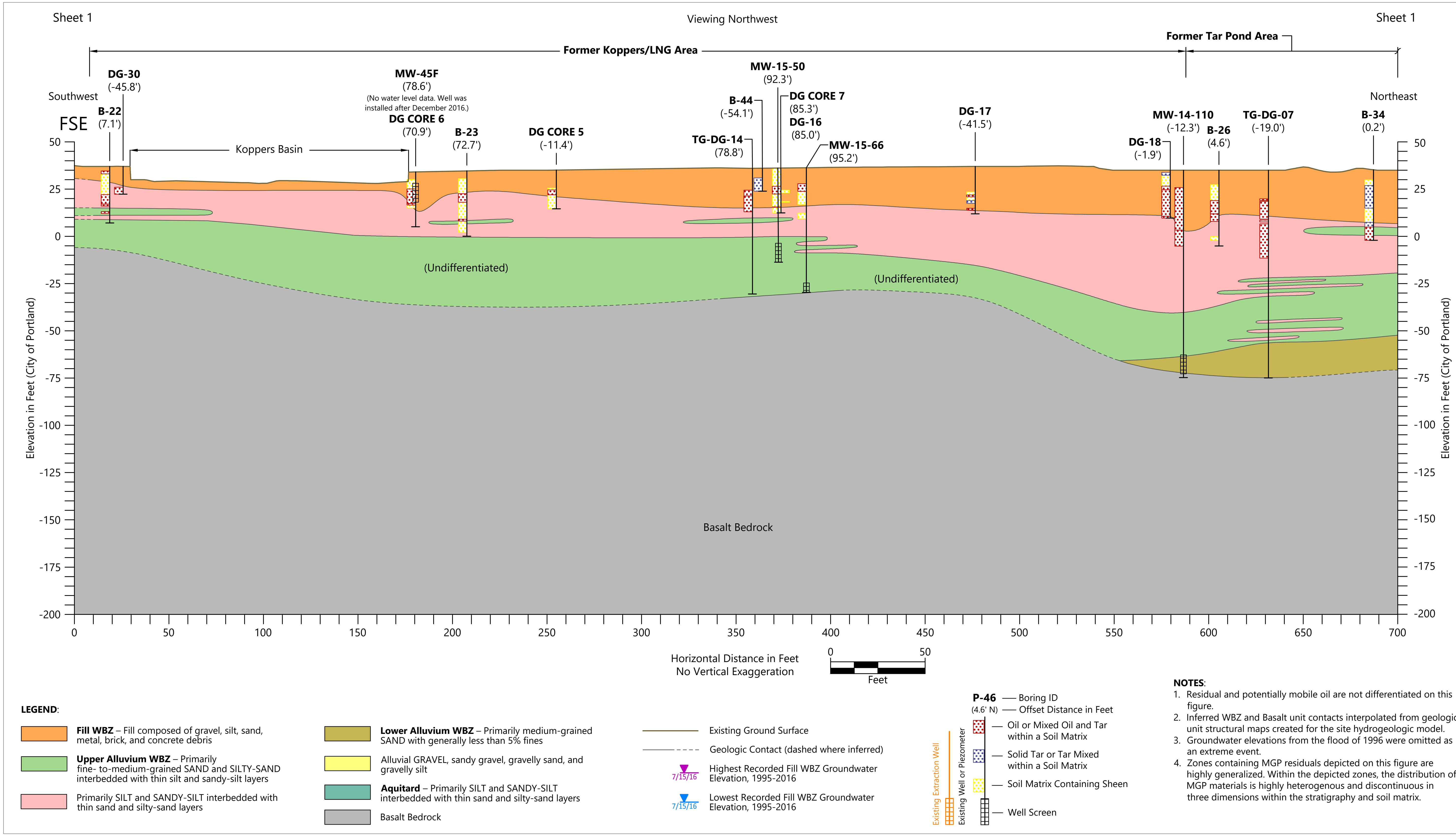

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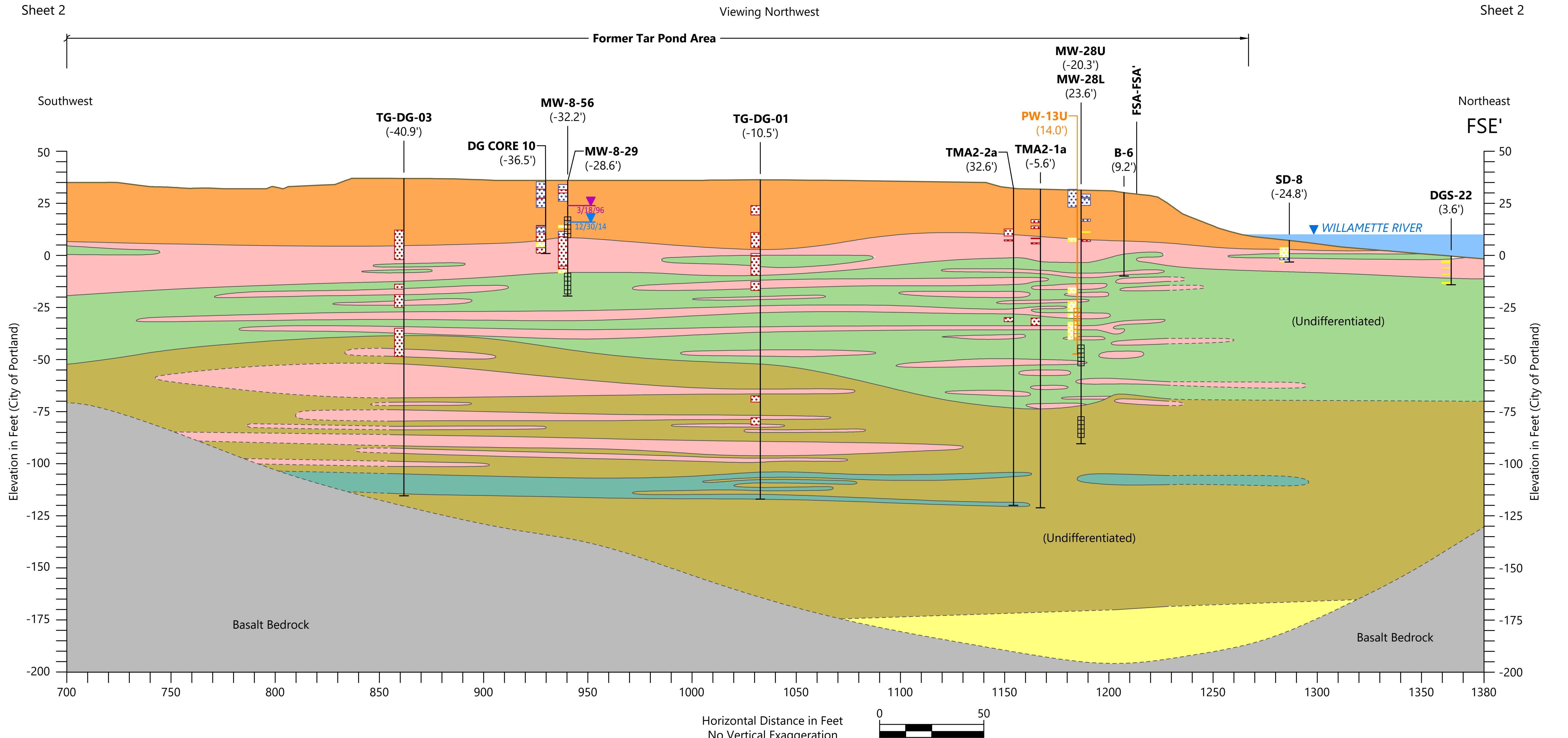
Figure 3-3f
Cross Section FSE-FSE' – Sheet 1 of 2
Interim Feasibility Study
Gasco OU



LEGEND:

Fill WBZ – Fill composed of gravel, silt, sand, metal, brick, and concrete debris

Upper Alluvium WBZ – Primarily fine- to-medium-grained SAND and SILTY-SAND interbedded with thin silt and sandy-silt layers

Primarily SILT and SANDY-SILT interbedded with thin sand and silty-sand layers

Lower Alluvium WBZ – Primarily medium-grained SAND with generally less than 5% fines

Alluvial GRAVEL, sandy gravel, gravelly sand, and gravelly silt

Aquitard – Primarily SILT and SANDY-SILT interbedded with thin sand and silty-sand layers

Basalt Bedrock

Existing Ground Surface

Geologic Contact (dashed where inferred)

7/15/16 Highest Recorded Fill WBZ Groundwater Elevation, 1995-2016

7/15/16 Lowest Recorded Fill WBZ Groundwater Elevation, 1995-2016

P-46 — Boring ID

(4.6' N) — Offset Distance in Feet

— Oil or Mixed Oil and Tar within a Soil Matrix

— Solid Tar or Tar Mixed within a Soil Matrix

— Soil Matrix Containing Sheen

— Well Screen

Existing Extraction Well

Existing Well or Piezometer

NOTES:

1. Residual and potentially mobile oil are not differentiated on this figure.
2. Inferred WBZ and Basalt unit contacts interpolated from geologic unit structural maps created for the site hydrogeologic model.
3. Groundwater elevations from the flood of 1996 were omitted as an extreme event.
4. Zones containing MGP residuals depicted on this figure are highly generalized. Within the depicted zones, the distribution of MGP materials is highly heterogenous and discontinuous in three dimensions within the stratigraphy and soil matrix.

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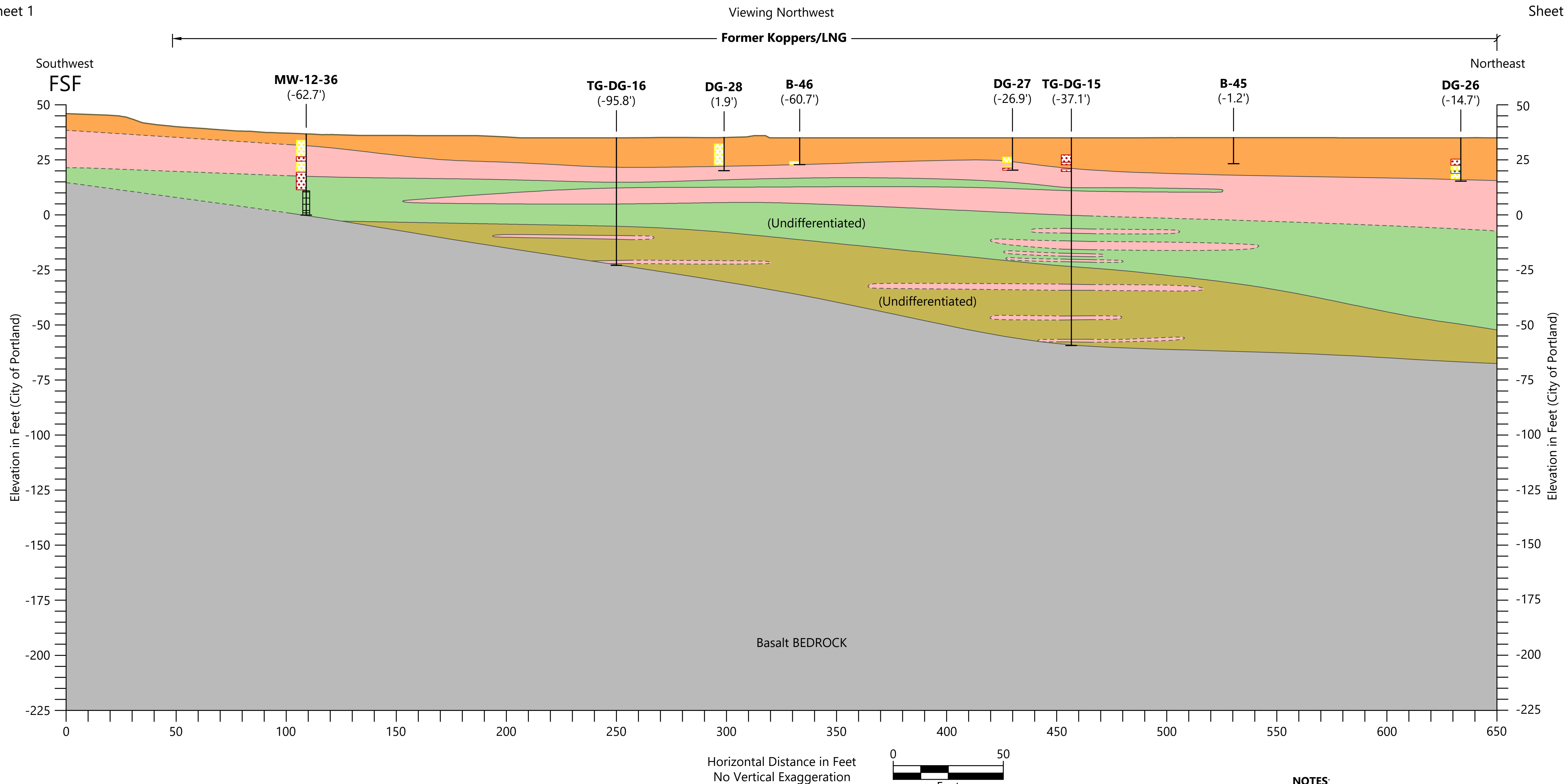
ANCHOR QEA

Figure 3-3f
Cross Section FSE-FSE' – Sheet 2 of 2

Interim Feasibility Study
Gasco OU



LEGEND:

Fill WBZ – Fill composed of gravel, silt, sand, metal, brick, and concrete debris

Upper Alluvium WBZ – Primarily fine- to-medium-grained SAND and SILTY-SAND interbedded with thin silt and sandy-silt layers

Primarily SILT and SANDY-SILT interbedded with thin sand and silty-sand layers

Lower Alluvium WBZ – Primarily medium-grained SAND with generally less than 5% fines

Alluvial GRAVEL, sandy gravel, gravelly sand, and gravelly silt

Aquitard – Primarily SILT and SANDY-SILT interbedded with thin sand and silty-sand layers

Basalt Bedrock

Existing Ground Surface

Geologic Contact (dashed where inferred)

P-46 — Boring ID

(4.6' N) — Offset Distance in Feet

Existing Extraction Well

Existing Well or Piezometer

— Oil or Mixed Oil and Tar within a Soil Matrix

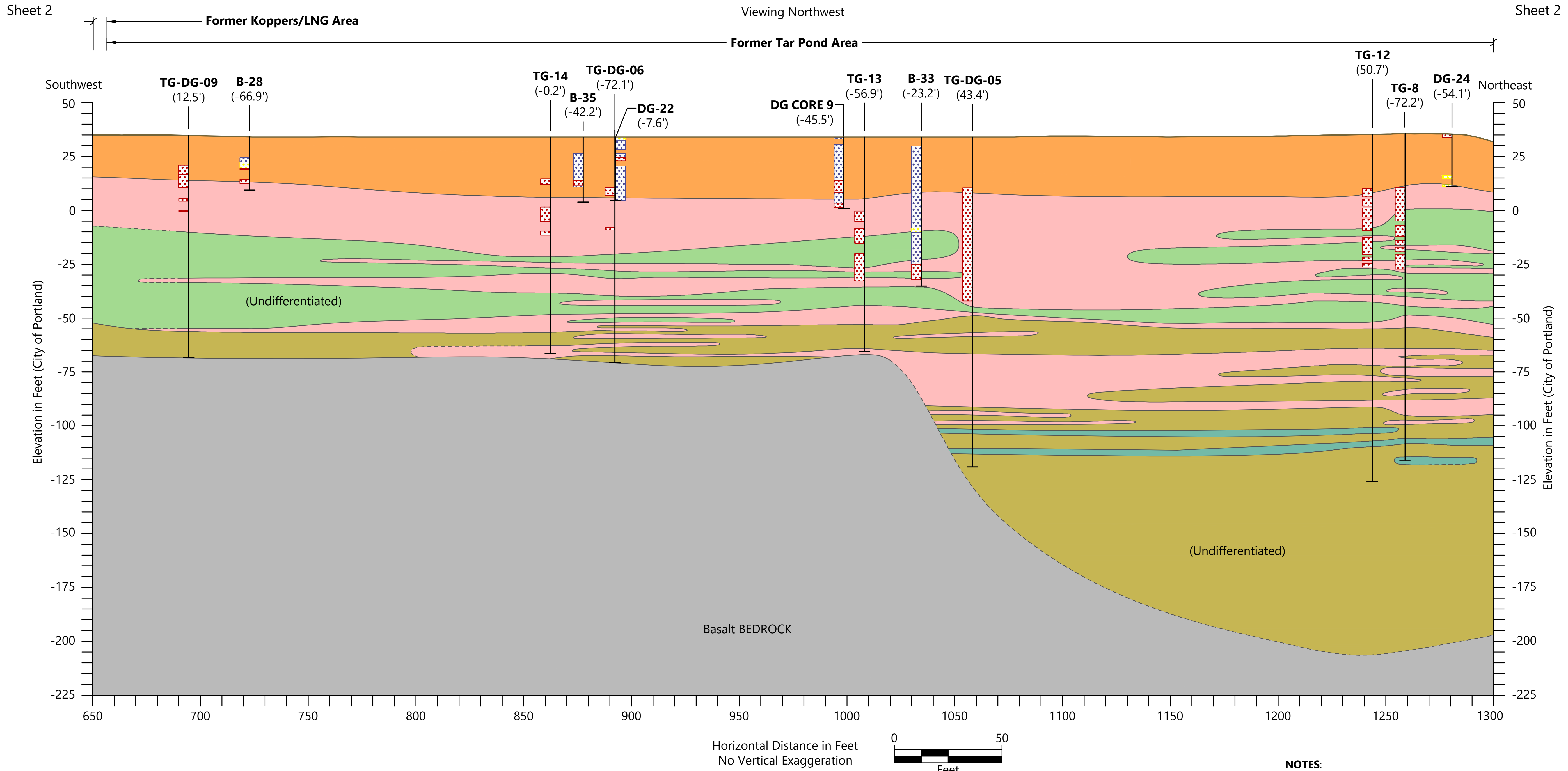
— Solid Tar or Tar Mixed within a Soil Matrix

— Soil Matrix Containing Sheen

— Well Screen

NOTES:

1. Residual and potentially mobile oil are not differentiated on this figure.
2. Inferred WBZ and Basalt unit contacts interpolated from geologic unit structural maps created for the site hydrogeologic model.
3. Locations GS-B7 and GS-C7 were logged for geologic contacts to 15 feet below mudline and then advanced without logging until refusal. Questionable contacts below that depth are interpolated from geologic unit structural maps created for the site hydrogeological model.
4. Zones containing MGP residuals depicted on this figure are highly generalized. Within the depicted zones, the distribution of MGP materials is highly heterogenous and discontinuous in three dimensions within the stratigraphy and soil matrix.



LEGEND:

- **Fill WBZ** – Fill composed of gravel, silt, sand, metal, brick, and concrete debris
- **Upper Alluvium WBZ** – Primarily fine- to-medium-grained SAND and SILTY-SAND interbedded with thin silt and sandy-silt layers
- Primarily SILT and SANDY-SILT interbedded with thin sand and silty-sand layers
- **Lower Alluvium WBZ** – Primarily medium-grained SAND with generally less than 5% fines
- Alluvial GRAVEL, sandy gravel, gravelly sand, and gravelly silt
- **Aquitard** – Primarily SILT and SANDY-SILT interbedded with thin sand and silty-sand layers
- Basalt Bedrock
- Existing Ground Surface
- Geologic Contact (dashed where inferred)

P-46 — Boring ID
(4.6' N) — Offset Distance in Feet
— Oil or Mixed Oil and Tar within a Soil Matrix
— Solid Tar or Tar Mixed within a Soil Matrix
— Soil Matrix Containing Sheen
— Well Screen
Existing Extraction Well
Existing Well or Piezometer

NOTES:

1. Residual and potentially mobile oil are not differentiated on this figure.
2. Inferred WBZ and Basalt unit contacts interpolated from geologic unit structural maps created for the site hydrogeologic model.
3. Locations GS-B7 and GS-C7 were logged for geologic contacts to 15 feet below mudline and then advanced without logging until refusal. Questionable contacts below that depth are interpolated from geologic unit structural maps created for the site hydrogeological model.
4. Zones containing MGP residuals depicted on this figure are highly generalized. Within the depicted zones, the distribution of MGP materials is highly heterogenous and discontinuous in three dimensions within the stratigraphy and soil matrix.

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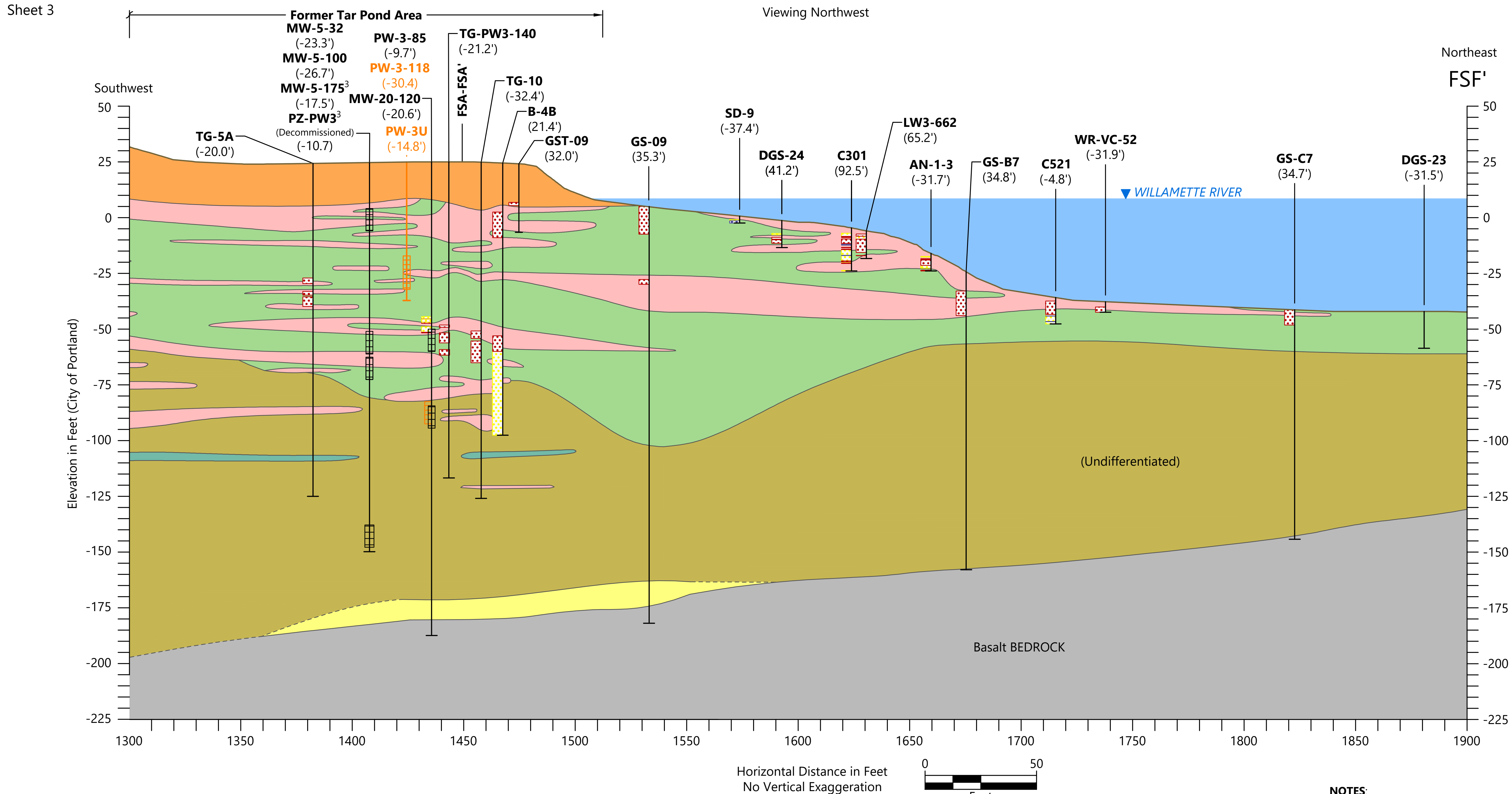
ANCHOR QEA

Figure 3-3g
Cross Section FSF-FSF' – Sheet 2 of 3

Interim Feasibility Study
Gasco OU



Horizontal Distance in Feet
No Vertical Exaggeration

0 50
Feet

LEGEND:

Fill WBZ – Fill composed of gravel, silt, sand, metal, brick, and concrete debris

Upper Alluvium WBZ – Primarily fine- to-medium-grained SAND and SILTY-SAND interbedded with thin silt and sandy-silt layers

Primarily SILT and SANDY-SILT interbedded with thin sand and silty-sand layers

Lower Alluvium WBZ – Primarily medium-grained SAND with generally less than 5% fines

Alluvial GRAVEL, sandy gravel, gravelly sand, and gravelly silt

Aquitard – Primarily SILT and SANDY-SILT interbedded with thin sand and silty-sand layers

Basalt Bedrock

Existing Ground Surface

Geologic Contact (dashed where inferred)

P-46 — Boring ID
(4.6' N) — Offset Distance in Feet

Oil or Mixed Oil and Tar within a Soil Matrix

Solid Tar or Tar Mixed within a Soil Matrix

Soil Matrix Containing Sheen

Well Screen

Existing Extraction Well

Existing Well or Piezometer

NOTES:
1. Residual and potentially mobile oil are not differentiated on this figure.
2. Inferred WBZ and Basalt unit contacts interpolated from geologic unit structural maps created for the site hydrogeologic model.
3. Locations GS-B7 and GS-C7 were logged for geologic contacts to 15 feet below mudline and then advanced without logging until refusal. Questionable contacts below that depth are interpolated from geologic unit structural maps created for the site hydrogeological model.
4. Zones containing MGP residuals depicted on this figure are highly generalized. Within the depicted zones, the distribution of MGP materials is highly heterogenous and discontinuous in three dimensions within the stratigraphy and soil matrix.

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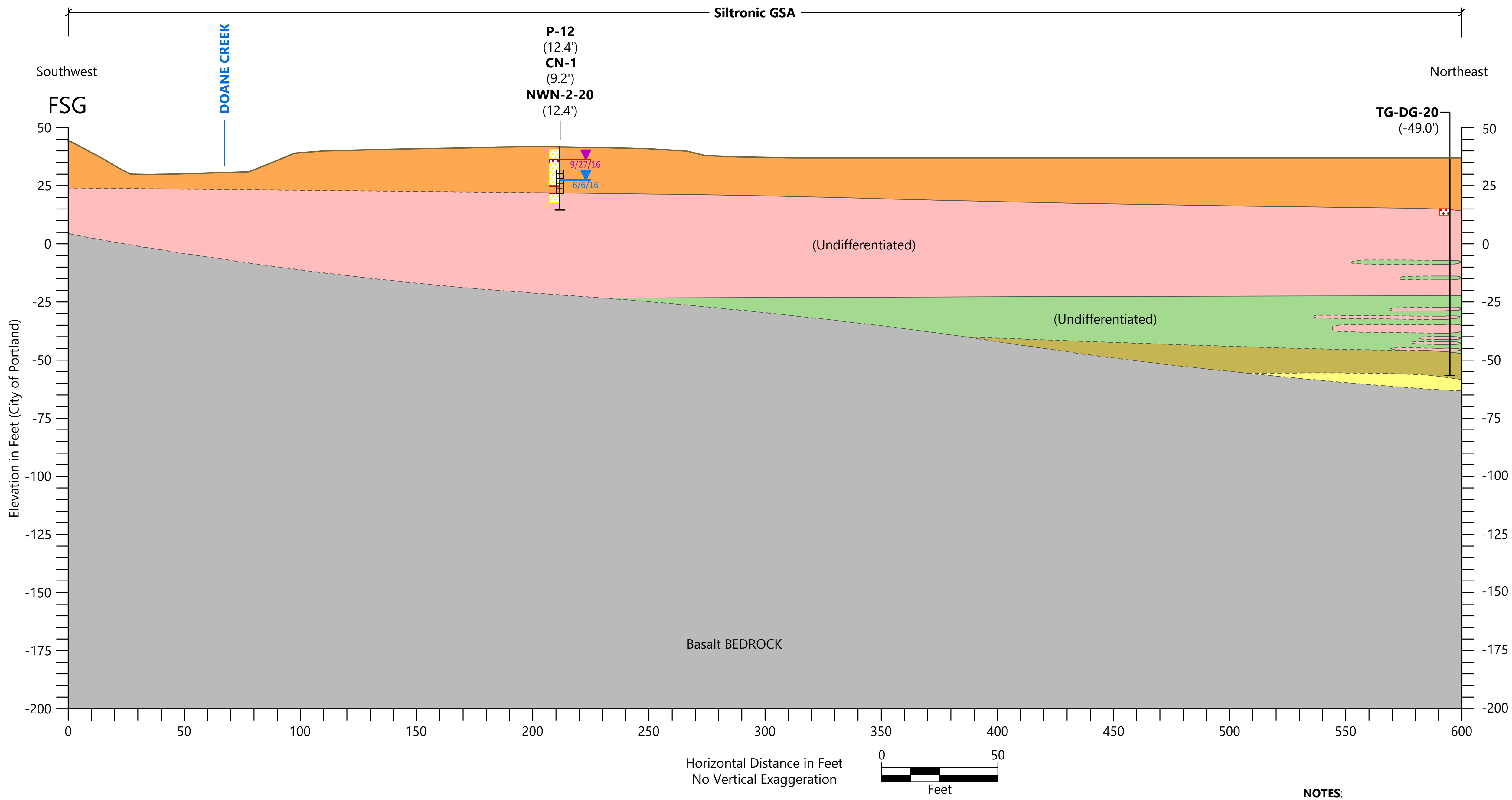
ANCHOR QEA

Figure 3-3g
Cross Section FSF-FSF' – Sheet 3 of 3

Interim Feasibility Study
Gasco OU

Sheet 1 Sheet 1



LEGEND:

- **Fill WBZ** – Fill composed of gravel, silt, sand, metal, brick, and concrete debris
- **Upper Alluvium WBZ** – Primarily fine- to-medium-grained SAND and SILTY-SAND interbedded with thin silt and sandy-silt layers
- Primarily SILT and SANDY-SILT interbedded with thin sand and silty-sand layers
- **Lower Alluvium WBZ** – Primarily medium-grained SAND with generally less than 5% fines
- Alluvial GRAVEL, sandy gravel, gravelly sand, and gravelly silt
- **Aquitard** – Primarily SILT and SANDY-SILT interbedded with thin sand and silty-sand layers
- Basalt Bedrock
- Existing Ground Surface
- Geologic Contact (dashed where inferred)
- 7/15/16 Highest Recorded Fill WBZ Groundwater Elevation, 1995-2016
- 7/15/16 Lowest Recorded Fill WBZ Groundwater Elevation, 1995-2016
- **P-46** — Boring ID
- (4.6' N) — Offset Distance in Feet
- Oil or Mixed Oil and Tar within a Soil Matrix
- Solid Tar or Tar Mixed within a Soil Matrix
- Soil Matrix Containing Sheen
- Well Screen
- Existing Extraction Well
- Existing Well or Piezometer

NOTES:

1. Residual and potentially mobile oil are not differentiated on this figure.
2. Inferred WBZ and Basalt unit contacts interpolated from geologic unit structural maps created for the site hydrogeologic model.
3. Groundwater elevations from the flood of 1996 were omitted as an extreme event.
4. Zones containing MGP residuals depicted on this figure are highly generalized. Within the depicted zones, the distribution of MGP materials is highly heterogenous and discontinuous in three dimensions within the stratigraphy and soil matrix.

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ANCHOR QEA

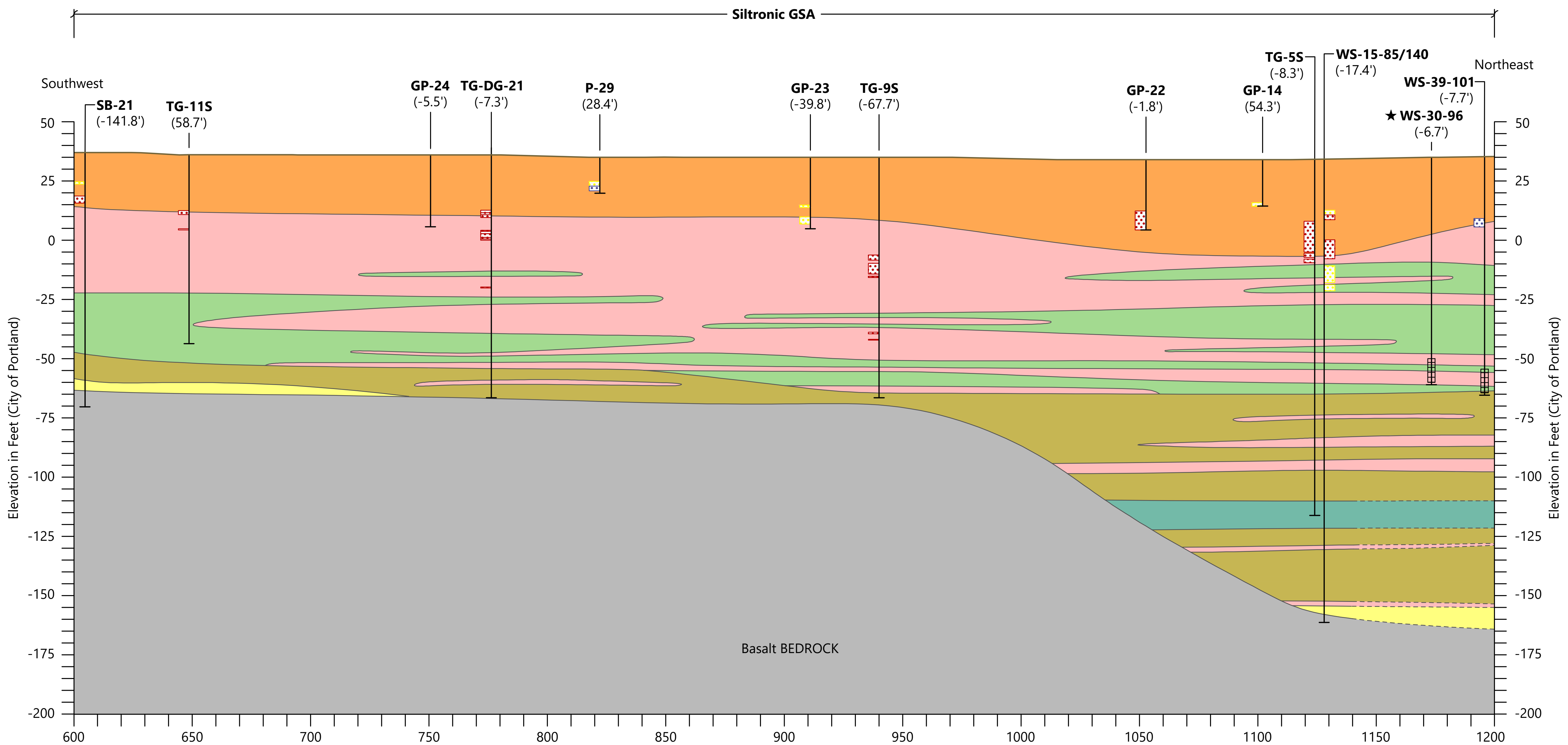
Figure 3-3h
Cross Section FSG-FSG' – Sheet 1 of 3

Interim Feasibility Study
Gasco OU

Sheet 2

Viewing Northwest

Sheet 2



LEGEND:

Fill WBZ – Fill composed of gravel, silt, sand, metal, brick, and concrete debris

Upper Alluvium WBZ – Primarily fine- to-medium-grained SAND and SILTY-SAND interbedded with thin silt and sandy-silt layers

Primarily SILT and SANDY-SILT interbedded with thin sand and silty-sand layers

Lower Alluvium WBZ – Primarily medium-grained SAND with generally less than 5% fines

Alluvial GRAVEL, sandy gravel, gravelly sand, and gravelly silt

Aquitard – Primarily SILT and SANDY-SILT interbedded with thin sand and silty-sand layers

Basalt Bedrock

Existing Ground Surface

Geologic Contact (dashed where inferred)

7/15/16 Highest Recorded Fill WBZ Groundwater Elevation, 1995-2016

7/15/16 Lowest Recorded Fill WBZ Groundwater Elevation, 1995-2016

P-46 — Boring ID
(4.6' N) — Offset Distance in Feet

Existing Extraction Well

Existing Well or Piezometer

— Oil or Mixed Oil and Tar within a Soil Matrix

— Solid Tar or Tar Mixed within a Soil Matrix

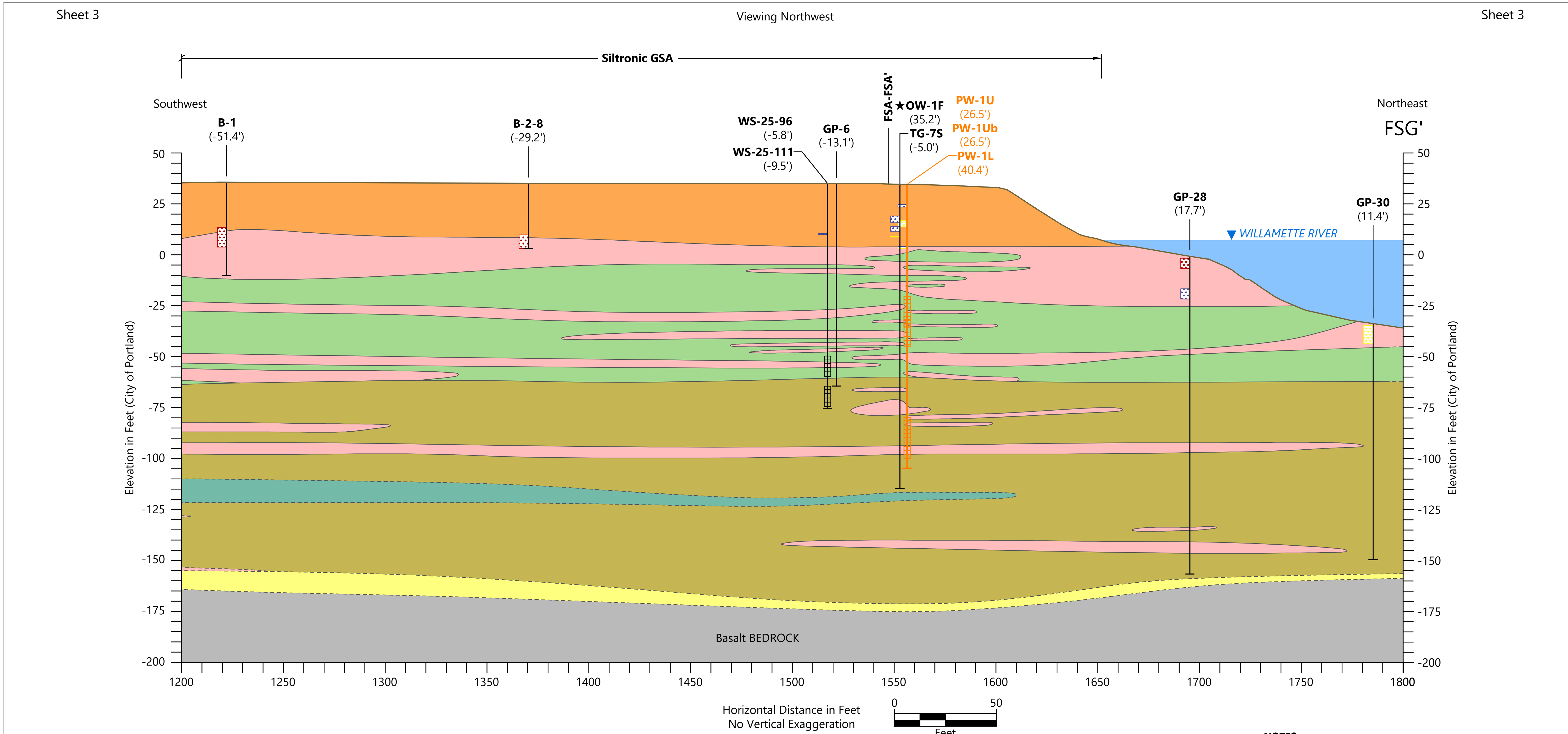
— Soil Matrix Containing Sheen

— Well Screen

NOTES:

1. Residual and potentially mobile oil are not differentiated on this figure.
2. Inferred WBZ and Basalt unit contacts interpolated from geologic unit structural maps created for the site hydrogeologic model.
3. Groundwater elevations from the flood of 1996 were omitted as an extreme event.
4. Zones containing MGP residuals depicted on this figure are highly generalized. Within the depicted zones, the distribution of MGP materials is highly heterogenous and discontinuous in three dimensions within the stratigraphy and soil matrix.

★ Not used for geologic interpretation



NOTES:
1. Residual and potentially mobile oil are not differentiated on this figure.
2. Inferred WBZ and Basalt unit contacts interpolated from geologic unit structural maps created for the site hydrogeologic model.
3. Groundwater elevations from the flood of 1996 were omitted as an extreme event.
4. Zones containing MGP residuals depicted on this figure are highly generalized. Within the depicted zones, the distribution of MGP materials is highly heterogenous and discontinuous in three dimensions within the stratigraphy and soil matrix.

★ Not used for geologic interpretation

LEGEND:

- **Fill WBZ** – Fill composed of gravel, silt, sand, metal, brick, and concrete debris
- **Upper Alluvium WBZ** – Primarily fine- to-medium-grained SAND and SILTY-SAND interbedded with thin silt and sandy-silt layers
- Primarily SILT and SANDY-SILT interbedded with thin sand and silty-sand layers
- **Lower Alluvium WBZ** – Primarily medium-grained SAND with generally less than 5% fines
- Alluvial GRAVEL, sandy gravel, gravelly sand, and gravelly silt
- **Aquitard** – Primarily SILT and SANDY-SILT interbedded with thin sand and silty-sand layers
- Basalt Bedrock
- Existing Ground Surface
- Geologic Contact (dashed where inferred)
- 7/15/16 Highest Recorded Fill WBZ Groundwater Elevation, 1995-2016
- 7/15/16 Lowest Recorded Fill WBZ Groundwater Elevation, 1995-2016
- **P-46** — Boring ID
- (4.6' N) — Offset Distance in Feet
- — Oil or Mixed Oil and Tar within a Soil Matrix
- — Solid Tar or Tar Mixed within a Soil Matrix
- — Soil Matrix Containing Sheen
- — Well Screen
- Existing Extraction Well
- Existing Well or Piezometer

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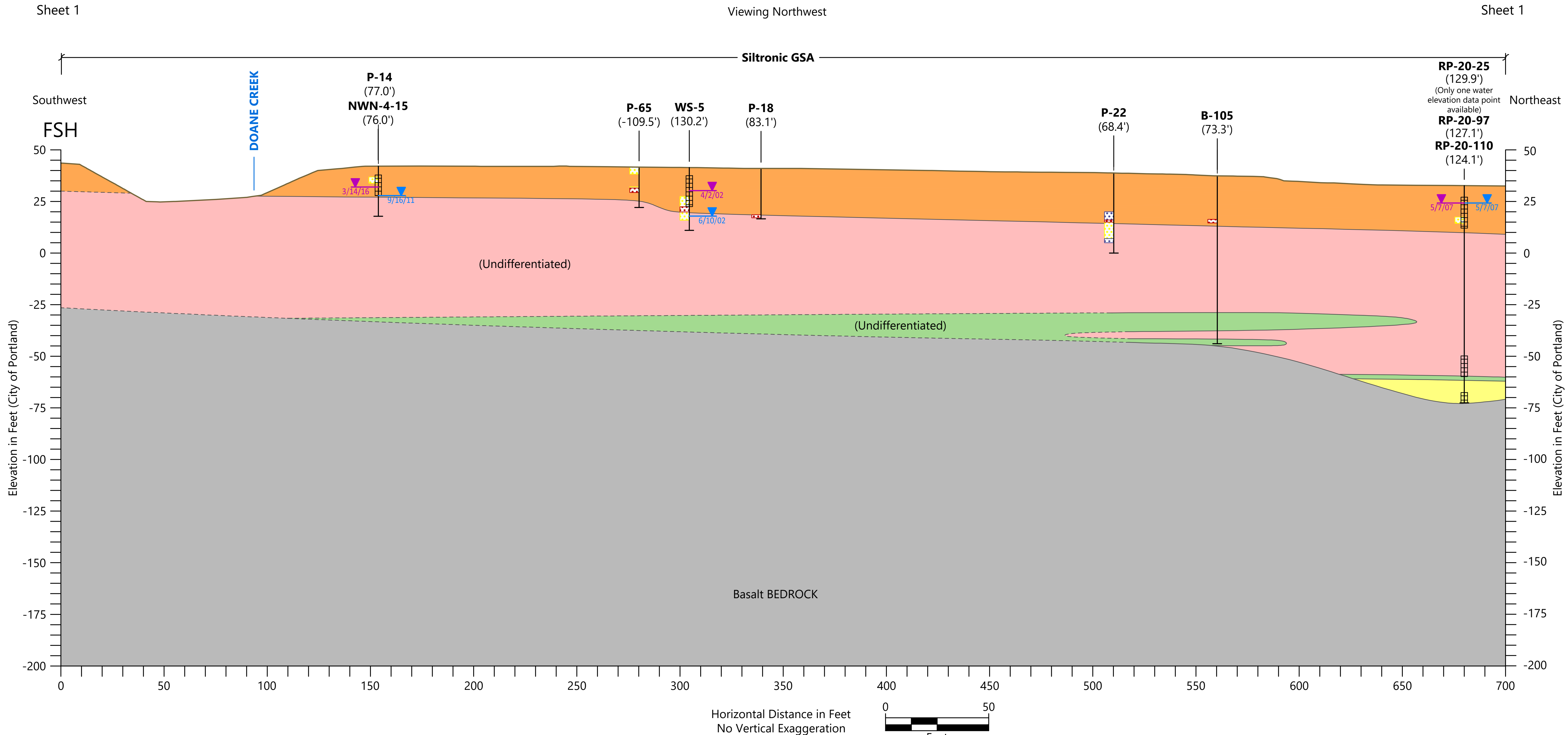
ANCHOR QEA

Figure 3-3h
Cross Section FSG-FSG' – Sheet 3 of 3

Interim Feasibility Study
Gasco OU



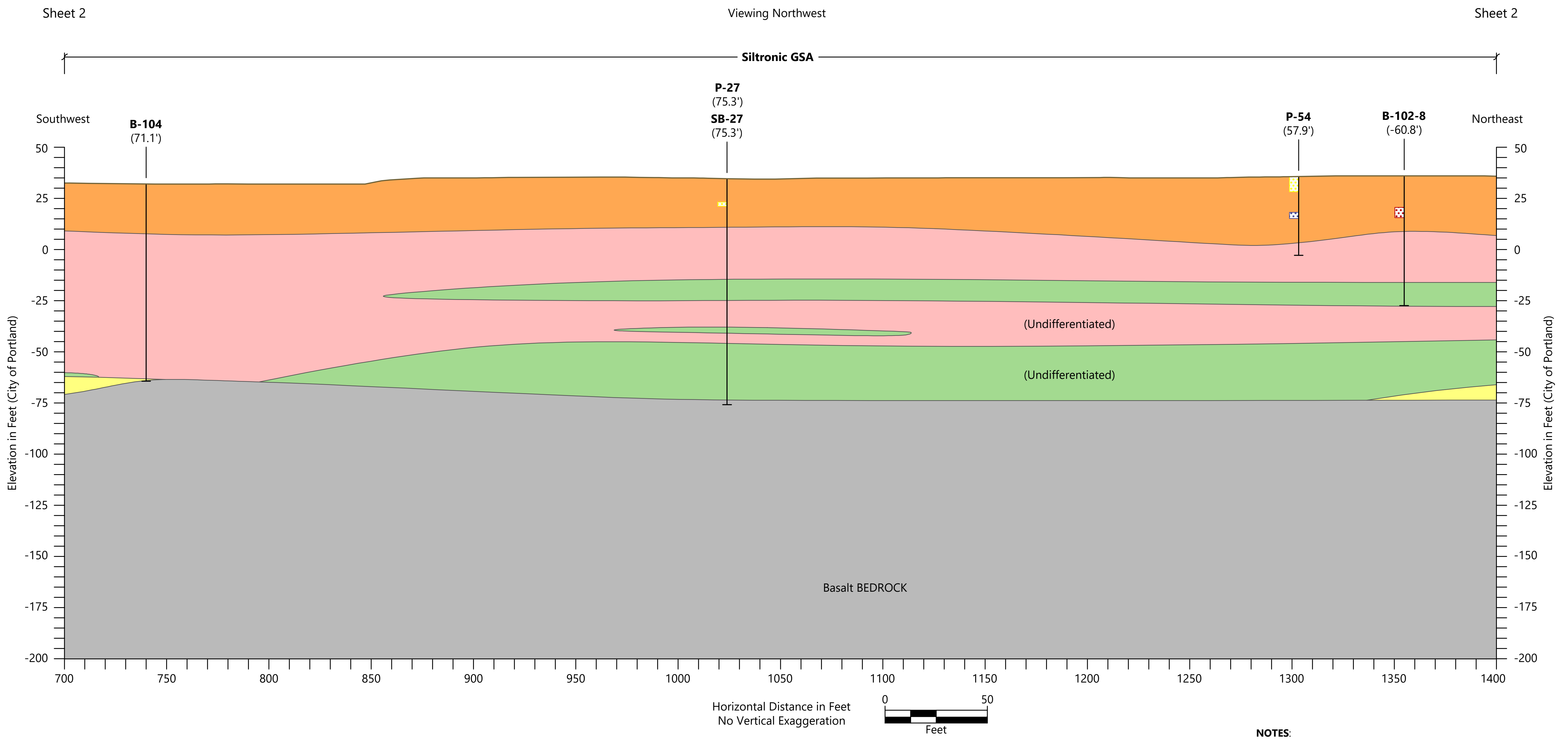
LEGEND:

- **Fill WBZ** – Fill composed of gravel, silt, sand, metal, brick, and concrete debris
- **Upper Alluvium WBZ** – Primarily fine- to-medium-grained SAND and SILTY-SAND interbedded with thin silt and sandy-silt layers
- Primarily SILT and SANDY-SILT interbedded with thin sand and silty-sand layers
- **Lower Alluvium WBZ** – Primarily medium-grained SAND with generally less than 5% fines
- Alluvial GRAVEL, sandy gravel, gravelly sand, and gravelly silt
- **Aquitard** – Primarily SILT and SANDY-SILT interbedded with thin sand and silty-sand layers
- Basalt Bedrock
- Existing Ground Surface
- Geologic Contact (dashed where inferred)
- 7/15/16 Highest Recorded Fill WBZ Groundwater Elevation, 1995-2016
- 7/15/16 Lowest Recorded Fill WBZ Groundwater Elevation, 1995-2016

P-46 — Boring ID
(4.6' N) — Offset Distance in Feet
Existing Extraction Well
Existing Well or Piezometer
— Oil or Mixed Oil and Tar within a Soil Matrix
— Solid Tar or Tar Mixed within a Soil Matrix
— Soil Matrix Containing Sheen
— Well Screen

NOTES:

1. Residual and potentially mobile oil are not differentiated on this figure.
2. Inferred WBZ and Basalt unit contacts interpolated from geologic unit structural maps created for the site hydrogeologic model.
3. Groundwater elevations from the flood of 1996 were omitted as an extreme event.
4. Zones containing MGP residuals depicted on this figure are highly generalized. Within the depicted zones, the distribution of MGP materials is highly heterogenous and discontinuous in three dimensions within the stratigraphy and soil matrix.



LEGEND:

Fill WBZ – Fill composed of gravel, silt, sand, metal, brick, and concrete debris

Upper Alluvium WBZ – Primarily fine- to-medium-grained SAND and SILTY-SAND interbedded with thin silt and sandy-silt layers

Primarily SILT and SANDY-SILT interbedded with thin sand and silty-sand layers

Lower Alluvium WBZ – Primarily medium-grained SAND with generally less than 5% fines

Alluvial GRAVEL, sandy gravel, gravelly sand, and gravelly silt

Aquitard – Primarily SILT and SANDY-SILT interbedded with thin sand and silty-sand layers

Basalt Bedrock

Existing Ground Surface

Geologic Contact (dashed where inferred)

7/15/16 Highest Recorded Fill WBZ Groundwater Elevation, 1995-2016

7/15/16 Lowest Recorded Fill WBZ Groundwater Elevation, 1995-2016

P-46 — Boring ID

(4.6' N) — Offset Distance in Feet

Oil or Mixed Oil and Tar within a Soil Matrix

Solid Tar or Tar Mixed within a Soil Matrix

Soil Matrix Containing Sheen

Well Screen

Existing Extraction Well

Existing Well or Piezometer

NOTES:

1. Residual and potentially mobile oil are not differentiated on this figure.
2. Inferred WBZ and Basalt unit contacts interpolated from geologic unit structural maps created for the site hydrogeologic model.
3. Groundwater elevations from the flood of 1996 were omitted as an extreme event.
4. Zones containing MGP residuals depicted on this figure are highly generalized. Within the depicted zones, the distribution of MGP materials is highly heterogenous and discontinuous in three dimensions within the stratigraphy and soil matrix.

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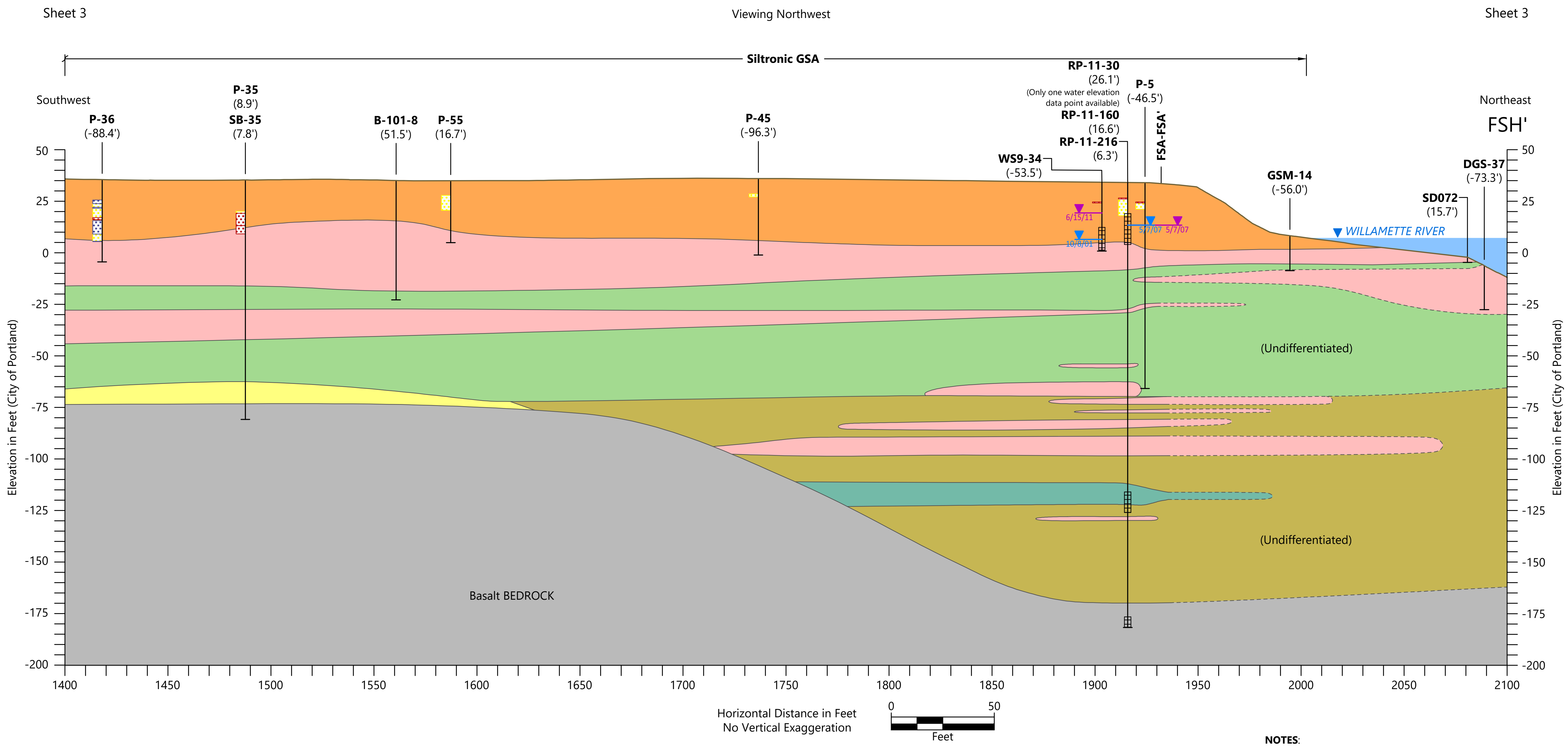
ANCHOR QEA

Figure 3-3i
Cross Section FSH-FSH' – Sheet 2 of 3



LEGEND:

- **Fill WBZ** – Fill composed of gravel, silt, sand, metal, brick, and concrete debris
- **Upper Alluvium WBZ** – Primarily fine- to-medium-grained SAND and SILTY-SAND interbedded with thin silt and sandy-silt layers
- Primarily SILT and SANDY-SILT interbedded with thin sand and silty-sand layers
- **Lower Alluvium WBZ** – Primarily medium-grained SAND with generally less than 5% fines
- Alluvial GRAVEL, sandy gravel, gravelly sand, and gravelly silt
- **Aquitard** – Primarily SILT and SANDY-SILT interbedded with thin sand and silty-sand layers
- Basalt Bedrock
- Existing Ground Surface
- Geologic Contact (dashed where inferred)
- 7/15/16 Highest Recorded Fill WBZ Groundwater Elevation, 1995-2016
- 7/15/16 Lowest Recorded Fill WBZ Groundwater Elevation, 1995-2016

P-46 — Boring ID
(4.6' N) — Offset Distance in Feet
Existing Extraction Well
Existing Well or Piezometer
— Oil or Mixed Oil and Tar within a Soil Matrix
— Solid Tar or Tar Mixed within a Soil Matrix
— Soil Matrix Containing Sheen
— Well Screen

NOTES:

1. Residual and potentially mobile oil are not differentiated on this figure.
2. Inferred WBZ and Basalt unit contacts interpolated from geologic unit structural maps created for the site hydrogeologic model.
3. Groundwater elevations from the flood of 1996 were omitted as an extreme event.
4. Zones containing MGP residuals depicted on this figure are highly generalized. Within the depicted zones, the distribution of MGP materials is highly heterogenous and discontinuous in three dimensions within the stratigraphy and soil matrix.

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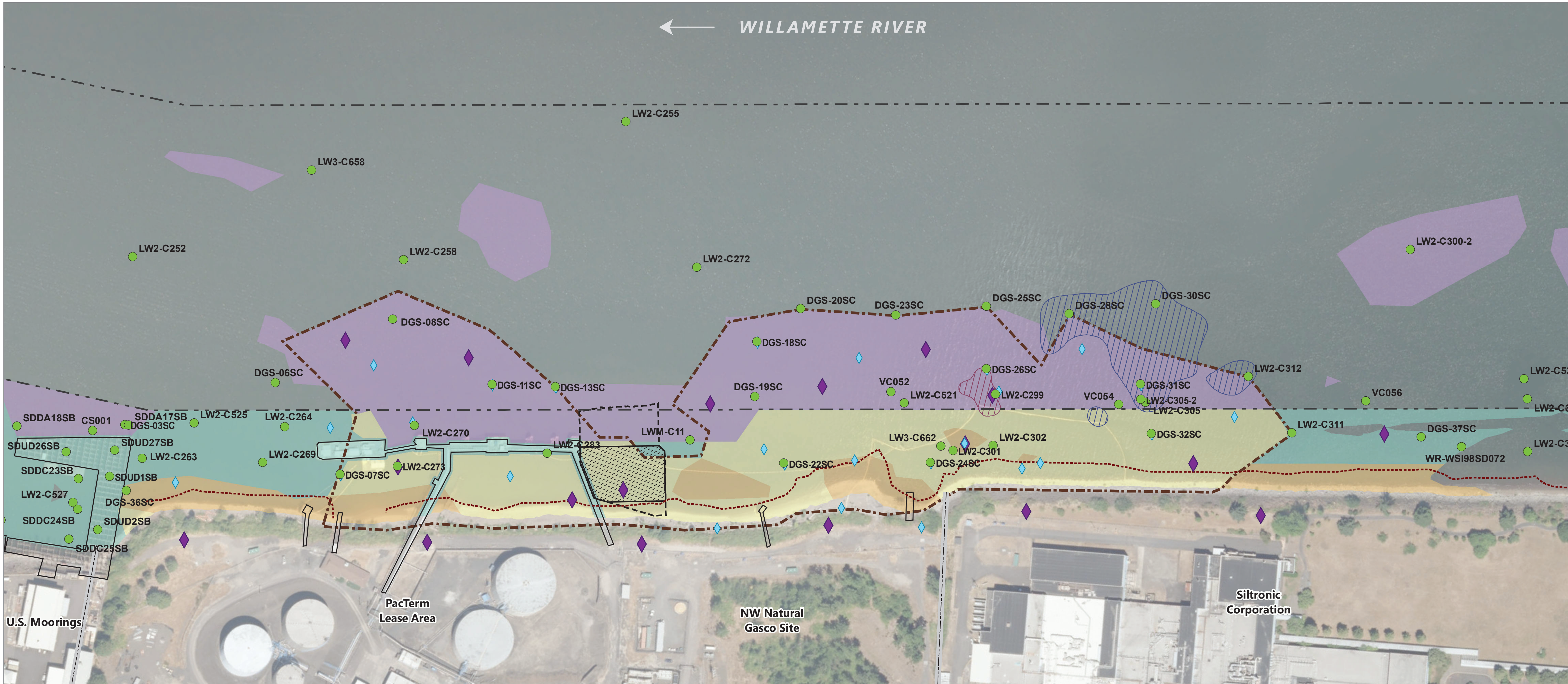
ANCHOR QEA

Figure 3-3i
Cross Section FSH-FSH' – Sheet 3 of 3
Interim Feasibility Study
Gasco OU

Attachment D
Oregon DEQ Risk-Based Concentration Exceedance Maps



LEGEND:

- Navigation Channel
- Structures
- Property Line
- Tar Body Removal Action Area (RAPP, Anchor 2005)
- Tar Body Removal Action Pilot Cap
- PTW-NAPL Boundary
- Approximate Riprap Boundary[1]

ROD SMA Technology[2]

- Cap
- Dredge
- Dredge in Nav-FMD
- Dredge with Cap
- 2010 Transition Zone Water Vinyl Chloride Area 1 Boundary (Anchor QEA 2012)[3]
- Area 2 – Detected CVOCs in TZW and One Subsurface Sediment Location[4]

- Existing TCLP Location
- Proposed TCLP/RBC Location
- Concentration is < DEQ DDD Occupational RBC of 12 ppm
- Concentration is ≥ DEQ DDD Occupational RBC of 12 ppm

NOTES:

1. Estimated from side scan sonar survey conducted by Blue Water Engineering April 2011.
2. All depicted SMA technology and PTW contours taken from the Portland Harbor Superfund Site Record of Decision (2017) without application of the EPA Explanation of Significant Differences (ESD; EPA 2018), which is not yet finalized.
3. Boundary taken from Draft Engineering Evaluation/Cost Analysis, Appendix A, Figure 4.2. Transition zone water screening level exceedances of cis-1,2-dichloroethene identified within this vinyl chloride boundary.
4. Boundary taken from Gasco Sediments Site Statement of Work, Figure 1 (EPA 2009).
5. The maximum concentration among all subsurface samples was compared to the Oregon DEQ's risk-based concentration of 12 mg/kg for 4,4'-DDD.
6. Arrow indicates direction of flow of river.
7. Horizontal datum is NAD83 (HARN 91) Oregon State Plane North, International Feet.
8. Vertical datum is City of Portland (COP), Feet.
9. Aerial imagery from City of Portland 2018.

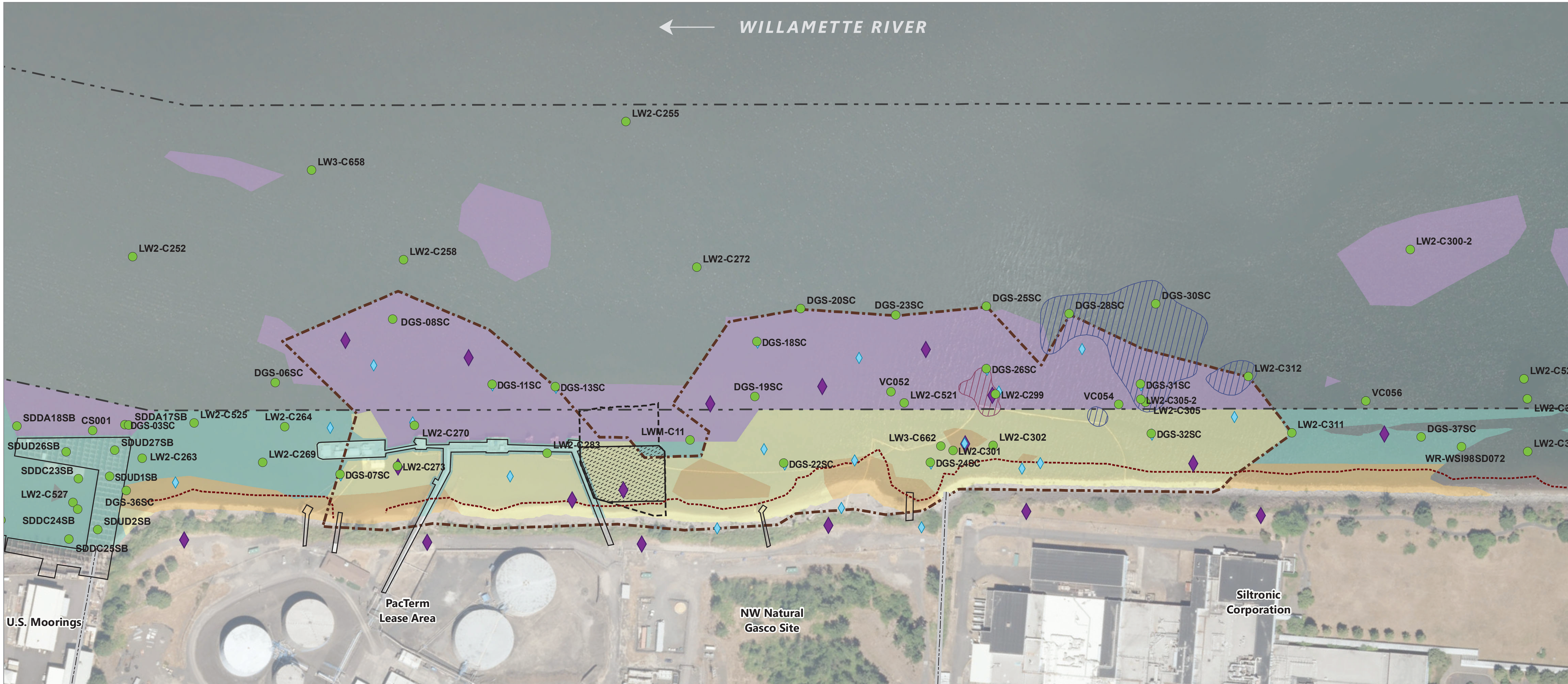
DDD: 4,4'-Dichlorodiphenyldichloroethane
TCLP: toxicity characteristic leaching procedure
RBC: risk-based concentration
DEQ: Department of Environmental Quality

0 200
Feet

Publish Date: 2019/08/16, 1:36 PM | User: alesueur
Filepath: \\orcas\gis\Jobs\NW_Natural_Gas_0029\Gasco_Sediments\Maps\requests\AQ_DEQ_RBC_Disposal_Evaluation_1to2400.mxd

ANCHOR QEA

Figure 1
Subsurface Sediment Exceedances of Oregon DEQ's Occupational Risk-Based Concentrations for 4,4'-DDD
Gasco Sediments Cleanup Action



LEGEND:

- Navigation Channel
- Structures
- Property Line
- Tar Body Removal Action Area (RAPP, Anchor 2005)
- Tar Body Removal Action Pilot Cap
- PTW-NAPL Boundary
- Approximate Riprap Boundary[1]

ROD SMA Technology[2]

- Cap
- Dredge
- Dredge in Nav-FMD
- Dredge with Cap
- 2010 Transition Zone Water Vinyl Chloride Area 1 Boundary (Anchor QEA 2012)[3]
- Area 2 – Detected CVOCs in TZW and One Subsurface Sediment Location[4]

- Existing TCLP Location
- Proposed TCLP/RBC Location
- Concentration is < DEQ DDE Occupational RBC of 8.2 ppm
- Concentration is ≥ DEQ DDE Occupational RBC of 8.2 ppm

NOTES:

1. Estimated from side scan sonar survey conducted by Blue Water Engineering April 2011.
2. All depicted SMA technology and PTW contours taken from the Portland Harbor Superfund Site Record of Decision (2017) without application of the EPA Explanation of Significant Differences (ESD; EPA 2018), which is not yet finalized.
3. Boundary taken from Draft Engineering Evaluation/Cost Analysis, Appendix A, Figure 4.2. Transition zone water screening level exceedances of cis-1,2-dichloroethene identified within this vinyl chloride boundary.
4. Boundary taken from Gasco Sediments Site Statement of Work, Figure 1 (EPA 2009).
5. The maximum concentration among all subsurface samples was compared to the Oregon DEQ's risk-based concentration of 8.2 mg/kg for 4,4'-DDE.
6. Arrow indicates direction of flow of river.
7. Horizontal datum is NAD83 (HARN 91) Oregon State Plane North, International Feet.
8. Vertical datum is City of Portland (COP), Feet.
9. Aerial imagery from City of Portland 2018.

DDE: 4,4'-Dichlorodiphenyldichloroethene
TCLP: toxicity characteristic leaching procedure
RBC: risk-based concentration
DEQ: Department of Environmental Quality

0 200
Feet

Publish Date: 2019/08/16, 1:37 PM | User: alesueur
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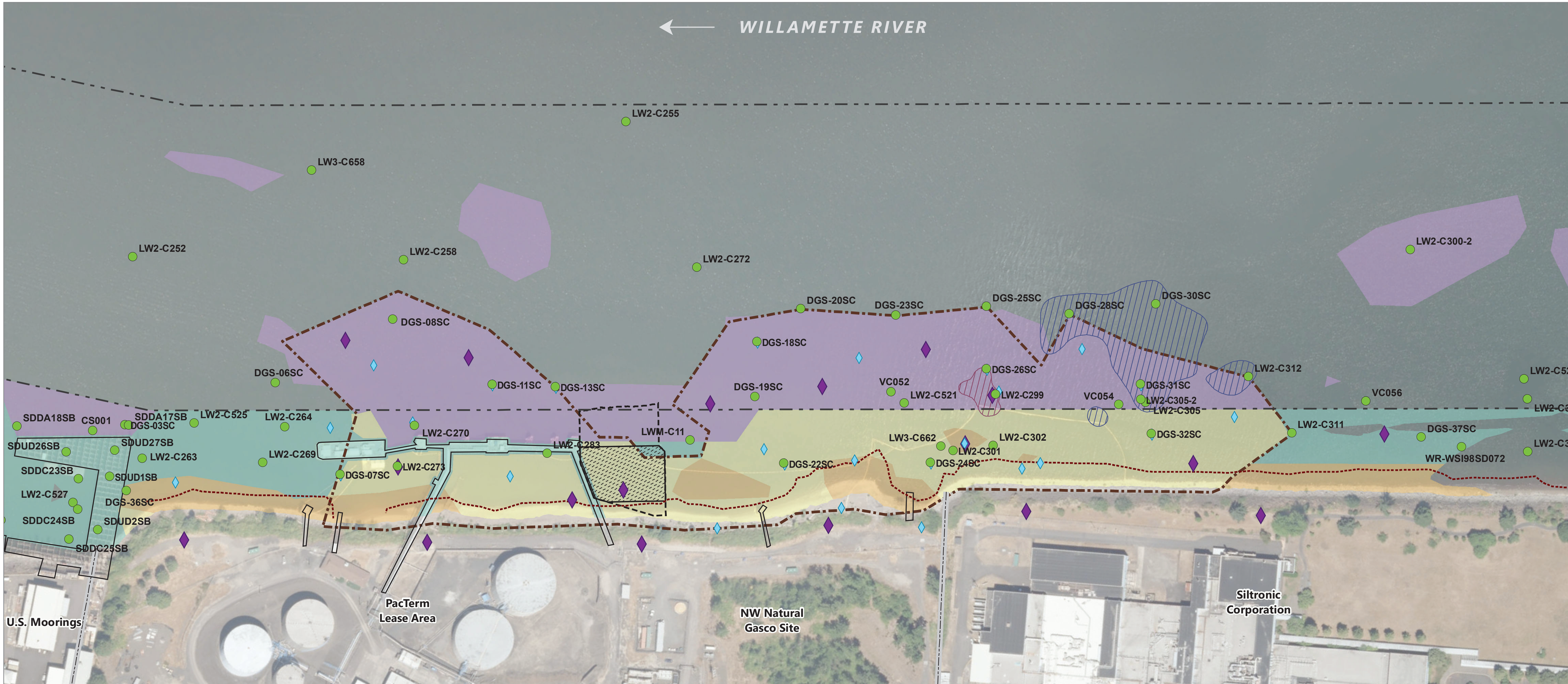
ANCHOR QEA

Figure 2
Subsurface Sediment Exceedances of Oregon DEQ's Occupational Risk-Based Concentrations for 4,4'-DDE
Gasco Sediments Cleanup Action



LEGEND:

- Navigation Channel
- Structures
- Property Line
- Tar Body Removal Action Area (RAPP, Anchor 2005)
- Tar Body Removal Action Pilot Cap
- PTW-NAPL Boundary
- Approximate Riprap Boundary[1]

ROD SMA Technology[2]

- Cap
- Dredge
- Dredge in Nav-FMD
- Dredge with Cap
- 2010 Transition Zone Water Vinyl Chloride Area 1 Boundary (Anchor QEA 2012)[3]
- Area 2 – Detected CVOCs in TZW and One Subsurface Sediment Location[4]

- Existing TCLP Location
- Proposed TCLP/RBC Location
- Concentration is < DEQ DDT Occupational RBC of 8.5 ppm
- Concentration is ≥ DEQ DDT Occupational RBC of 8.5 ppm

NOTES:

1. Estimated from side scan sonar survey conducted by Blue Water Engineering April 2011.
2. All depicted SMA technology and PTW contours taken from the Portland Harbor Superfund Site Record of Decision (2017) without application of the EPA Explanation of Significant Differences (ESD; EPA 2018), which is not yet finalized.
3. Boundary taken from Draft Engineering Evaluation/Cost Analysis, Appendix A, Figure 4.2. Transition zone water screening level exceedances of cis-1,2-dichloroethene identified within this vinyl chloride boundary.
4. Boundary taken from Gasco Sediments Site Statement of Work, Figure 1 (EPA 2009).
5. The maximum concentration among all subsurface samples was compared to the Oregon DEQ's risk-based concentration of 8.5 mg/kg for 4,4'-DDT.
6. Arrow indicates direction of flow of river.
7. Horizontal datum is NAD83 (HARN 91) Oregon State Plane North, International Feet.
8. Vertical datum is City of Portland (COP), Feet.
9. Aerial imagery from City of Portland 2018.

DDT: 4,4'-Dichlorodiphenyltrichloroethane
TCLP: toxicity characteristic leaching procedure
RBC: risk-based concentration
DEQ: Department of Environmental Quality

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ANCHOR QEA

Figure 3
Subsurface Sediment Exceedances of Oregon DEQ's Occupational Risk-Based Concentrations for 4,4'-DDT
Gasco Sediments Cleanup Action

LEGEND:

- Navigation Channel
- Structures
- Property Line
- Tar Body Removal Action Area (RAPP, Anchor 2005)
- Tar Body Removal Action Pilot Cap
- PTW-NAPL Boundary
- Approximate Riprap Boundary[1]

ROD SMA Technology[2]

- Cap
- Dredge
- Dredge in Nav-FMD
- Dredge with Cap
- 2010 Transition Zone Water Vinyl Chloride Area 1 Boundary (Anchor QEA 2012)[3]
- Area 2 – Detected CVOCs in TZW and One Subsurface Sediment Location[4]

- Existing TCLP Location
- Proposed TCLP/RBC Location
- Concentration is < DEQ TCE Occupational RBC of 51 ppm
- Concentration is ≥ DEQ TCE Occupational RBC of 51 ppm

NOTES:

1. Estimated from side scan sonar survey conducted by Blue Water Engineering April 2011.
2. All depicted SMA technology and PTW contours taken from the Portland Harbor Superfund Site Record of Decision (2017) without application of the EPA Explanation of Significant Differences (ESD; EPA 2018), which is not yet finalized.
3. Boundary taken from Draft Engineering Evaluation/Cost Analysis, Appendix A, Figure 4.2. Transition zone water screening level exceedances of cis-1,2-dichloroethene identified within this vinyl chloride boundary.
4. Boundary taken from Gasco Sediments Site Statement of Work, Figure 1 (EPA 2009).
5. The maximum concentration among all subsurface samples was compared to the Oregon DEQ's risk-based concentration of 51 mg/kg for TCE.
6. Arrow indicates direction of flow of river.
7. Horizontal datum is NAD83 (HARN 91) Oregon State Plane North, International Feet.
8. Vertical datum is City of Portland (COP), Feet.
9. Aerial imagery from City of Portland 2018.

TCE: trichloroethene
TCLP: toxicity characteristic leaching procedure
RBC: risk-based concentration
DEQ: Department of Environmental Quality

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ANCHOR QEA

Figure 4
Subsurface Sediment Exceedances of Oregon DEQ's Occupational Risk-Based Concentrations for TCE
Gasco Sediments Cleanup Action

LEGEND:

- Navigation Channel
- Structures
- Property Line
- Tar Body Removal Action Area (RAPP, Anchor 2005)
- Tar Body Removal Action Pilot Cap
- PTW-NAPL Boundary
- Approximate Riprap Boundary[1]

ROD SMA Technology[2]

- Cap
- Dredge
- Dredge in Nav-FMD
- Dredge with Cap
- 2010 Transition Zone Water Vinyl Chloride Area 1 Boundary (Anchor QEA 2012)[3]
- Area 2 – Detected CVOCs in TZW and One Subsurface Sediment Location[4]

- Existing TCLP Location
- Proposed TCLP/RBC Location
- Concentration is < DEQ DCE Occupational RBC of 2,300 ppm
- Concentration is ≥ DEQ DCE Occupational RBC of 2,300 ppm

NOTES:

1. Estimated from side scan sonar survey conducted by Blue Water Engineering April 2011.
2. All depicted SMA technology and PTW contours taken from the Portland Harbor Superfund Site Record of Decision (2017) without application of the EPA Explanation of Significant Differences (ESD; EPA 2018), which is not yet finalized.
3. Boundary taken from Draft Engineering Evaluation/Cost Analysis, Appendix A, Figure 4.2. Transition zone water screening level exceedances of cis-1,2-dichloroethene identified within this vinyl chloride boundary.
4. Boundary taken from Gasco Sediments Site Statement of Work, Figure 1 (EPA 2009).
5. The maximum concentration among all subsurface samples was compared to the Oregon DEQ's risk-based concentration of 2,300 mg/kg for cis-1,2-DCE .
6. Arrow indicates direction of flow of river.
7. Horizontal datum is NAD83 (HARN 91) Oregon State Plane North, International Feet.
8. Vertical datum is City of Portland (COP), Feet.
9. Aerial imagery from City of Portland 2018.

cis-1,2-DCE: cis-1,2-Dichloroethene
TCLP: toxicity characteristic leaching procedure
RBC: risk-based concentration
DEQ: Department of Environmental Quality

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Figure 5
Subsurface Sediment Exceedances of Oregon DEQ's Occupational Risk-Based Concentrations for cis-1,2-DCE
Gasco Sediments Cleanup Action

LEGEND:

- Navigation Channel
- Structures
- Property Line
- Tar Body Removal Action Area (RAPP, Anchor 2005)
- Tar Body Removal Action Pilot Cap
- PTW-NAPL Boundary
- Approximate Riprap Boundary[1]

ROD SMA Technology[2]

- Cap
- Dredge
- Dredge in Nav-FMD
- Dredge with Cap
- 2010 Transition Zone Water Vinyl Chloride Area 1 Boundary (Anchor QEA 2012)[3]
- Area 2 – Detected CVOCs in TZW and One Subsurface Sediment Location[4]

- Existing TCLP Location
- Proposed TCLP/RBC Location
- Concentration is < DEQ VC Occupational RBC of 4.4 ppm
- Concentration is ≥ DEQ VC Occupational RBC of 4.4 ppm

NOTES:

1. Estimated from side scan sonar survey conducted by Blue Water Engineering April 2011.
2. All depicted SMA technology and PTW contours taken from the Portland Harbor Superfund Site Record of Decision (2017) without application of the EPA Explanation of Significant Differences (ESD; EPA 2018), which is not yet finalized.
3. Boundary taken from Draft Engineering Evaluation/Cost Analysis, Appendix A, Figure 4.2. Transition zone water screening level exceedances of cis-1,2-dichloroethene identified within this vinyl chloride boundary.
4. Boundary taken from Gasco Sediments Site Statement of Work, Figure 1 (EPA 2009).
5. The maximum concentration among all subsurface samples was compared to the Oregon DEQ's risk-based concentration of 4.4 mg/kg for Vinyl Chloride.
6. Arrow indicates direction of flow of river.
7. Horizontal datum is NAD83 (HARN 91) Oregon State Plane North, International Feet.
8. Vertical datum is City of Portland (COP), Feet.
9. Aerial imagery from City of Portland 2018.

VC: Vinyl Chloride
TCLP: toxicity characteristic leaching procedure
RBC: risk-based concentration
DEQ: Department of Environmental Quality

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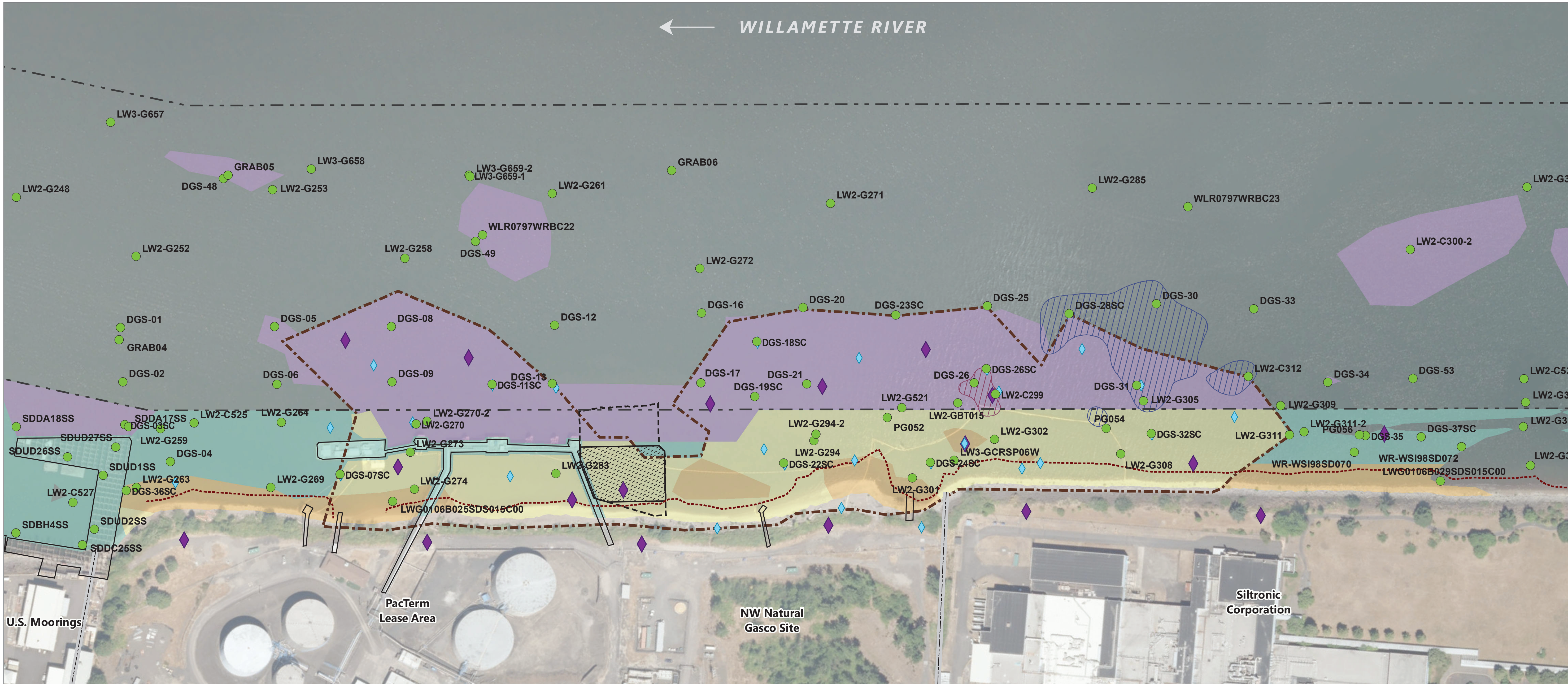
Figure 6
Subsurface Sediment Exceedances of Oregon DEQ's Occupational Risk-Based Concentrations for Vinyl Chloride
Gasco Sediments Cleanup Action



LEGEND:

- Navigation Channel
- Structures
- Property Line
- Tar Body Removal Action Area (RAPP, Anchor 2005)
- Tar Body Removal Action Pilot Cap
- PTW-NAPL Boundary
- Approximate Riprap Boundary[1]

ROD SMA Technology[2]

- Cap
- Dredge
- Dredge in Nav-FMD
- Dredge with Cap
- 2010 Transition Zone Water Vinyl Chloride Area 1 Boundary (Anchor QEA 2012)[3]
- Area 2 – Detected CVOCs in TZW and One Subsurface Sediment Location[4]

- Existing TCLP Location
- Proposed TCLP/RBC Location
- Concentration is < DEQ DDD Occupational RBC of 12 ppm
- Concentration is ≥ DEQ DDD Occupational RBC of 12 ppm

NOTES:

1. Estimated from side scan sonar survey conducted by Blue Water Engineering April 2011.
2. All depicted SMA technology and PTW contours taken from the Portland Harbor Superfund Site Record of Decision (2017) without application of the EPA Explanation of Significant Differences (ESD; EPA 2018), which is not yet finalized.
3. Boundary taken from Draft Engineering Evaluation/Cost Analysis, Appendix A, Figure 4.2. Transition zone water screening level exceedances of cis-1,2-dichloroethene identified within this vinyl chloride boundary.
4. Boundary taken from Gasco Sediments Site Statement of Work, Figure 1 (EPA 2009).
5. The maximum concentration among all subsurface samples was compared to the Oregon DEQ's risk-based concentration of 12 mg/kg for 4,4'-DDD.
6. Arrow indicates direction of flow of river.
7. Horizontal datum is NAD83 (HARN 91) Oregon State Plane North, International Feet.
8. Vertical datum is City of Portland (COP), Feet.
9. Aerial imagery from City of Portland 2018.

DDD: 4,4'-Dichlorodiphenyldichloroethane
TCLP: toxicity characteristic leaching procedure
RBC: risk-based concentration
DEQ: Department of Environmental Quality

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Feet

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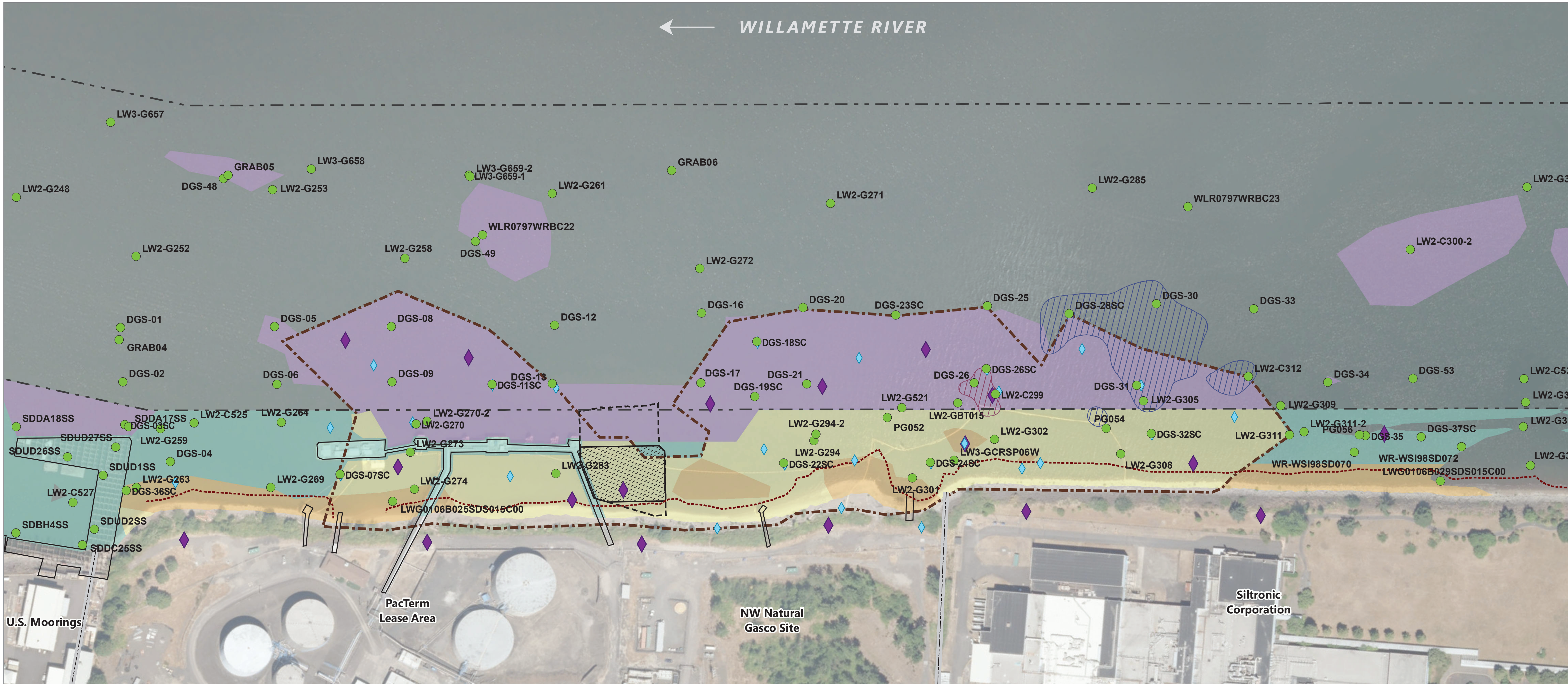
Figure 7
Surface Sediment Exceedances of Oregon DEQ's Occupational Risk-Based Concentrations for 4,4'-DDD
Gasco Sediments Cleanup Action



LEGEND:

- Navigation Channel
- Structures
- Property Line
- Tar Body Removal Action Area (RAPP, Anchor 2005)
- Tar Body Removal Action Pilot Cap
- PTW-NAPL Boundary
- Approximate Riprap Boundary[1]

ROD SMA Technology[2]

- Cap
- Dredge
- Dredge in Nav-FMD
- Dredge with Cap
- 2010 Transition Zone Water Vinyl Chloride Area 1 Boundary (Anchor QEA 2012)[3]
- Area 2 – Detected CVOCs in TZW and One Subsurface Sediment Location[4]

- Existing TCLP Location
- Proposed TCLP/RBC Location
- Concentration is < DEQ DDE Occupational RBC of 8.2 ppm
- Concentration is ≥ DEQ DDE Occupational RBC of 8.2 ppm

NOTES:

1. Estimated from side scan sonar survey conducted by Blue Water Engineering April 2011.
2. All depicted SMA technology and PTW contours taken from the Portland Harbor Superfund Site Record of Decision (2017) without application of the EPA Explanation of Significant Differences (ESD; EPA 2018), which is not yet finalized.
3. Boundary taken from Draft Engineering Evaluation/Cost Analysis, Appendix A, Figure 4.2. Transition zone water screening level exceedances of cis-1,2-dichloroethene identified within this vinyl chloride boundary.
4. Boundary taken from Gasco Sediments Site Statement of Work, Figure 1 (EPA 2009).
5. The maximum concentration among all subsurface samples was compared to the Oregon DEQ's risk-based concentration of 8.2 mg/kg for 4,4'-DDE.
6. Arrow indicates direction of flow of river.
7. Horizontal datum is NAD83 (HARN 91) Oregon State Plane North, International Feet.
8. Vertical datum is City of Portland (COP), Feet.
9. Aerial imagery from City of Portland 2018.

DDE: 4,4'-Dichlorodiphenyldichloroethene
TCLP: toxicity characteristic leaching procedure
RBC: risk-based concentration
DEQ: Department of Environmental Quality

0 200
Feet

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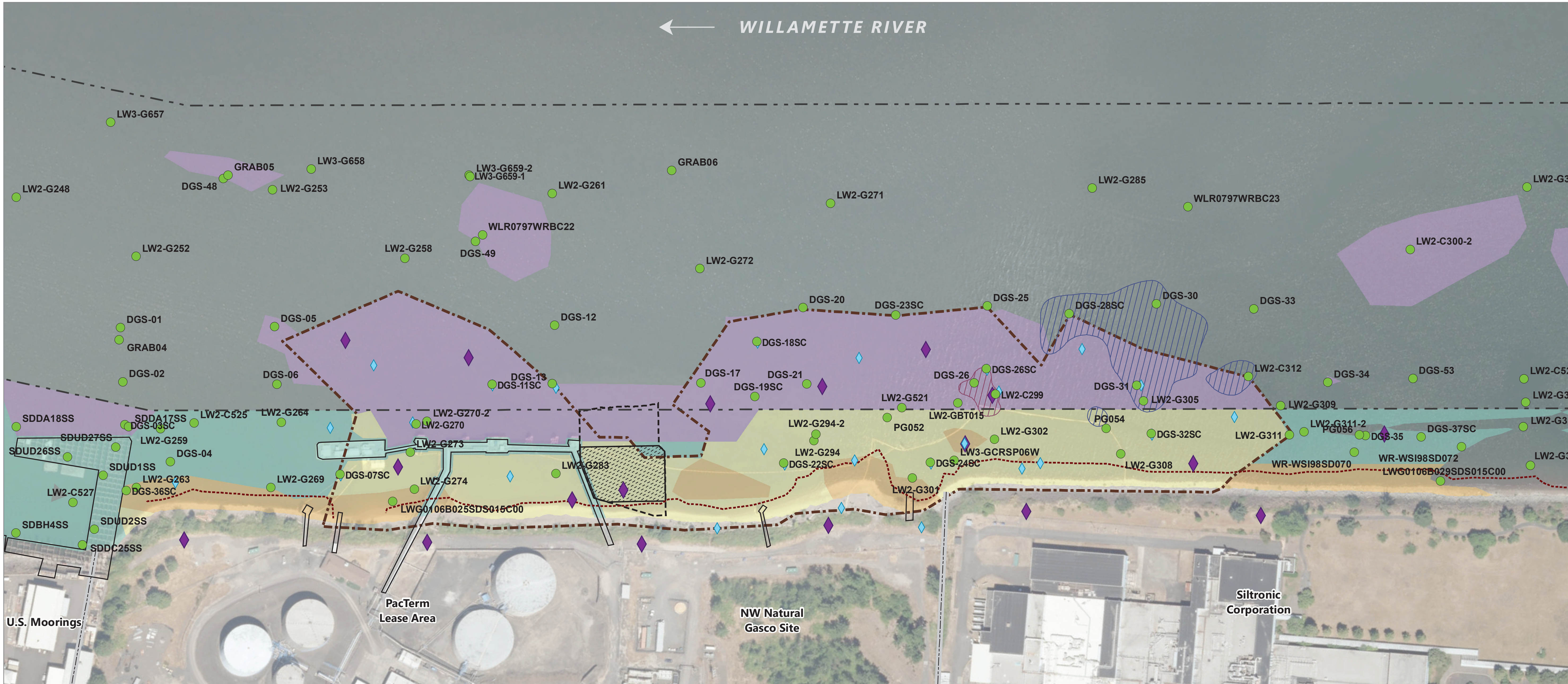
Figure 8
Surface Sediment Exceedances of Oregon DEQ's Occupational Risk-Based Concentrations for 4,4'-DDE
Gasco Sediments Cleanup Action



LEGEND:

- Navigation Channel
- Structures
- Property Line
- Tar Body Removal Action Area (RAPP, Anchor 2005)
- Tar Body Removal Action Pilot Cap
- PTW-NAPL Boundary
- Approximate Riprap Boundary[1]

ROD SMA Technology[2]

- Cap
- Dredge
- Dredge in Nav-FMD
- Dredge with Cap
- 2010 Transition Zone Water Vinyl Chloride Area 1 Boundary (Anchor QEA 2012)[3]
- Area 2 – Detected CVOCs in TZW and One Subsurface Sediment Location[4]

- Existing TCLP Location
- Proposed TCLP/RBC Location
- Concentration is < DEQ DDT Occupational RBC of 8.5 ppm
- Concentration is ≥ DEQ DDT Occupational RBC of 8.5 ppm

NOTES:

1. Estimated from side scan sonar survey conducted by Blue Water Engineering April 2011.
2. All depicted SMA technology and PTW contours taken from the Portland Harbor Superfund Site Record of Decision (2017) without application of the EPA Explanation of Significant Differences (ESD; EPA 2018), which is not yet finalized.
3. Boundary taken from Draft Engineering Evaluation/Cost Analysis, Appendix A, Figure 4.2. Transition zone water screening level exceedances of cis-1,2-dichloroethene identified within this vinyl chloride boundary.
4. Boundary taken from Gasco Sediments Site Statement of Work, Figure 1 (EPA 2009).
5. The maximum concentration among all subsurface samples was compared to the Oregon DEQ's risk-based concentration of 8.5 mg/kg for 4,4'-DDT.
6. Arrow indicates direction of flow of river.
7. Horizontal datum is NAD83 (HARN 91) Oregon State Plane North, International Feet.
8. Vertical datum is City of Portland (COP), Feet.
9. Aerial imagery from City of Portland 2018.

DDT: 4,4'-Dichlorodiphenyltrichloroethane
TCLP: toxicity characteristic leaching procedure
RBC: risk-based concentration
DEQ: Department of Environmental Quality

0 200
Feet

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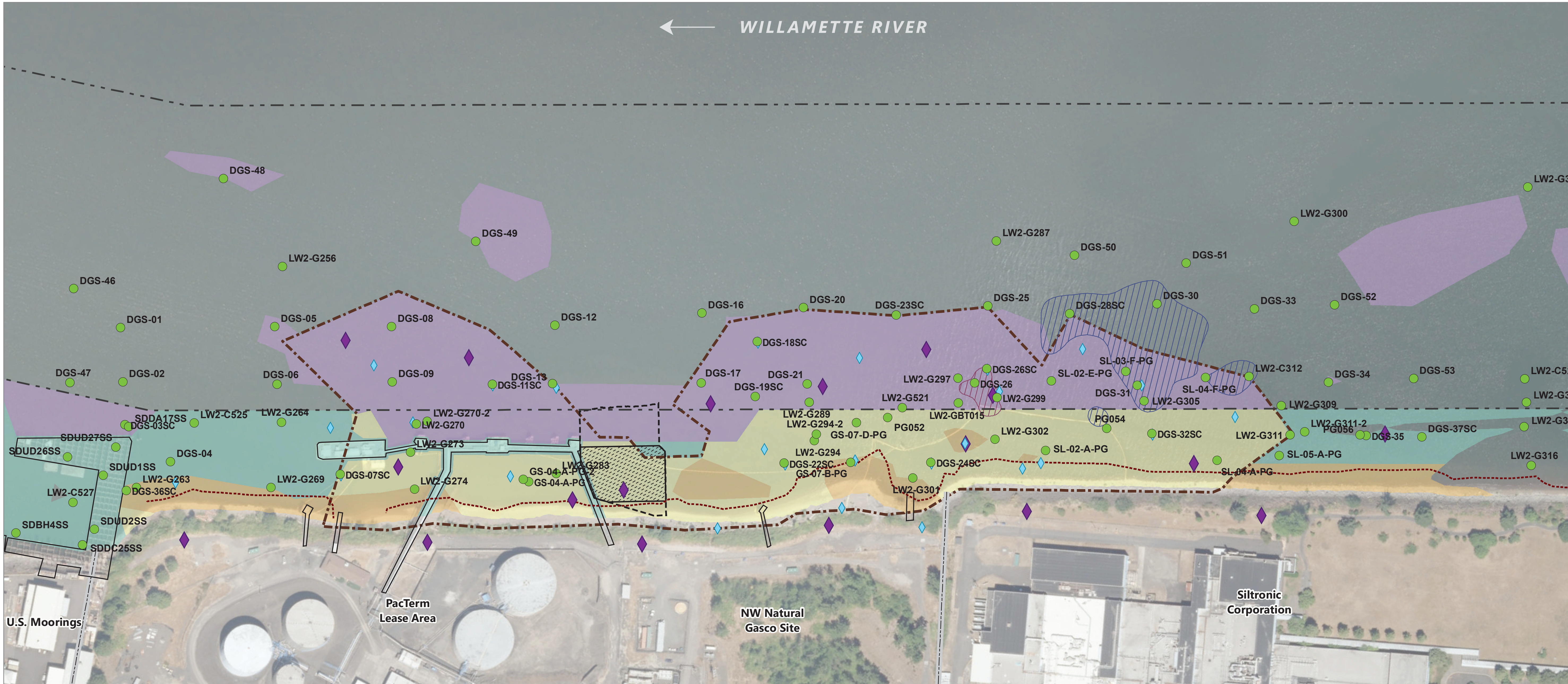
Figure 9
Surface Sediment Exceedances of Oregon DEQ's Occupational Risk-Based Concentrations for 4,4'-DDT
Gasco Sediments Cleanup Action



LEGEND:

- Navigation Channel
- Structures
- Property Line
- Tar Body Removal Action Area (RAPP, Anchor 2005)
- Tar Body Removal Action Pilot Cap
- PTW-NAPL Boundary
- Approximate Riprap Boundary[1]

ROD SMA Technology[2]

- Cap
- Dredge
- Dredge in Nav-FMD
- Dredge with Cap
- 2010 Transition Zone Water Vinyl Chloride Area 1 Boundary (Anchor QEA 2012)[3]
- Area 2 – Detected CVOCs in TZW and One Subsurface Sediment Location[4]

- Existing TCLP Location
- Proposed TCLP/RBC Location
- Concentration is < DEQ TCE Occupational RBC of 51 ppm
- Concentration is ≥ DEQ TCE Occupational RBC of 51 ppm

NOTES:

1. Estimated from side scan sonar survey conducted by Blue Water Engineering April 2011.
2. All depicted SMA technology and PTW contours taken from the Portland Harbor Superfund Site Record of Decision (2017) without application of the EPA Explanation of Significant Differences (ESD; EPA 2018), which is not yet finalized.
3. Boundary taken from Draft Engineering Evaluation/Cost Analysis, Appendix A, Figure 4.2. Transition zone water screening level exceedances of cis-1,2-dichloroethene identified within this vinyl chloride boundary.
4. Boundary taken from Gasco Sediments Site Statement of Work, Figure 1 (EPA 2009).
5. The maximum concentration among all subsurface samples was compared to the Oregon DEQ's risk-based concentration of 51 mg/kg for TCE.
6. Arrow indicates direction of flow of river.
7. Horizontal datum is NAD83 (HARN 91) Oregon State Plane North, International Feet.
8. Vertical datum is City of Portland (COP), Feet.
9. Aerial imagery from City of Portland 2018.

TCE: trichloroethene
TCLP: toxicity characteristic leaching procedure
RBC: risk-based concentration
DEQ: Department of Environmental Quality

0 200
Feet

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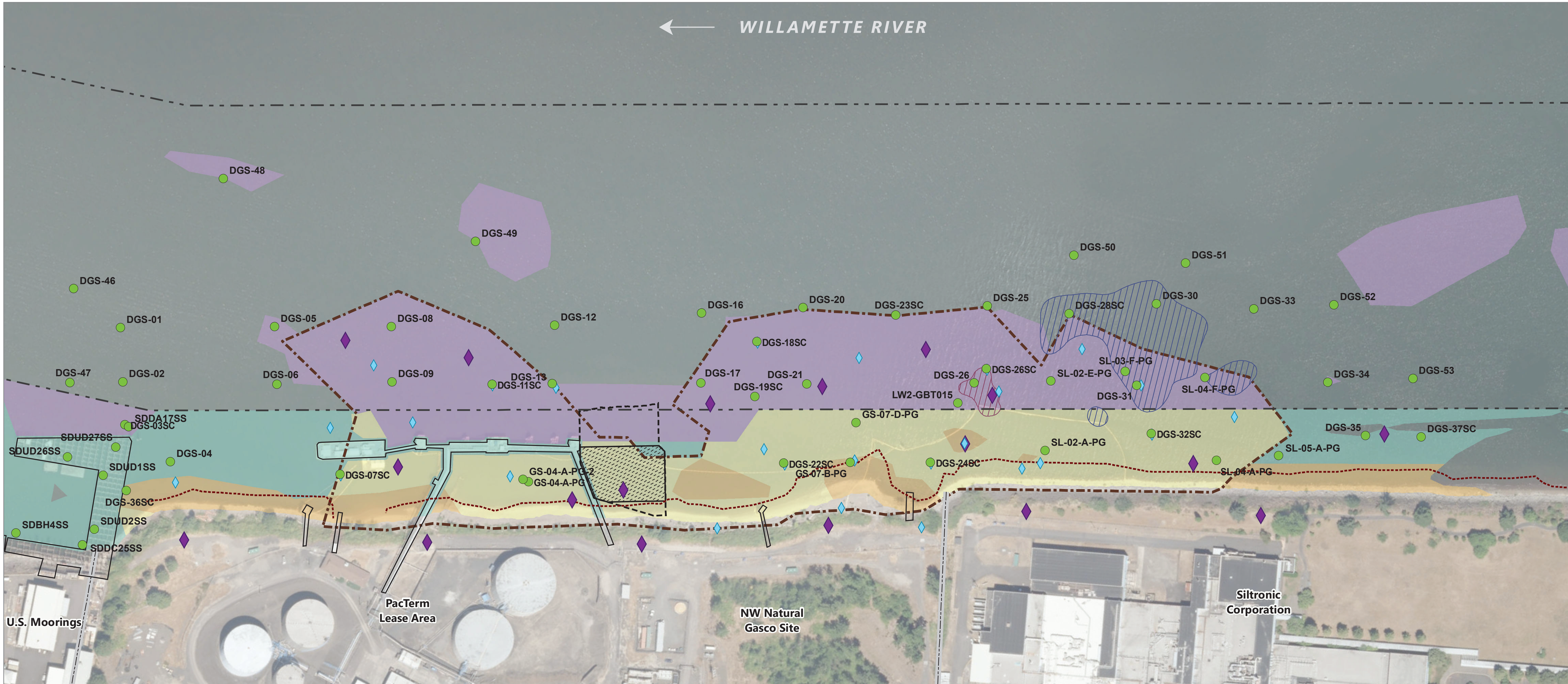
Figure 10
Surface Sediment Exceedances of Oregon DEQ's Occupational Risk-Based Concentrations for TCE
Gasco Sediments Cleanup Action



LEGEND:

- Navigation Channel
- Structures
- Property Line
- Tar Body Removal Action Area (RAPP, Anchor 2005)
- Tar Body Removal Action Pilot Cap
- PTW-NAPL Boundary
- Approximate Riprap Boundary[1]

ROD SMA Technology[2]

- Cap
- Dredge
- Dredge in Nav-FMD
- Dredge with Cap
- 2010 Transition Zone Water Vinyl Chloride Area 1 Boundary (Anchor QEA 2012)[3]
- Area 2 – Detected CVOCs in TZW and One Subsurface Sediment Location[4]

- Existing TCLP Location
- Proposed TCLP/RBC Location
- Concentration is < DEQ DCE Occupational RBC of 2,300 ppm
- Concentration is ≥ DEQ DCE Occupational RBC of 2,300 ppm

NOTES:

1. Estimated from side scan sonar survey conducted by Blue Water Engineering April 2011.
2. All depicted SMA technology and PTW contours taken from the Portland Harbor Superfund Site Record of Decision (2017) without application of the EPA Explanation of Significant Differences (ESD; EPA 2018), which is not yet finalized.
3. Boundary taken from Draft Engineering Evaluation/Cost Analysis, Appendix A, Figure 4.2. Transition zone water screening level exceedances of cis-1,2-dichloroethene identified within this vinyl chloride boundary.
4. Boundary taken from Gasco Sediments Site Statement of Work, Figure 1 (EPA 2009).
5. The maximum concentration among all subsurface samples was compared to the Oregon DEQ's risk-based concentration of 2,300 mg/kg for cis-1,2-DCE .
6. Arrow indicates direction of flow of river.
7. Horizontal datum is NAD83 (HARN 91) Oregon State Plane North, International Feet.
8. Vertical datum is City of Portland (COP), Feet.
9. Aerial imagery from City of Portland 2018.

cis-1,2-DCE: cis-1,2-Dichloroethene
TCLP: toxicity characteristic leaching procedure
RBC: risk-based concentration
DEQ: Department of Environmental Quality

0 200
Feet

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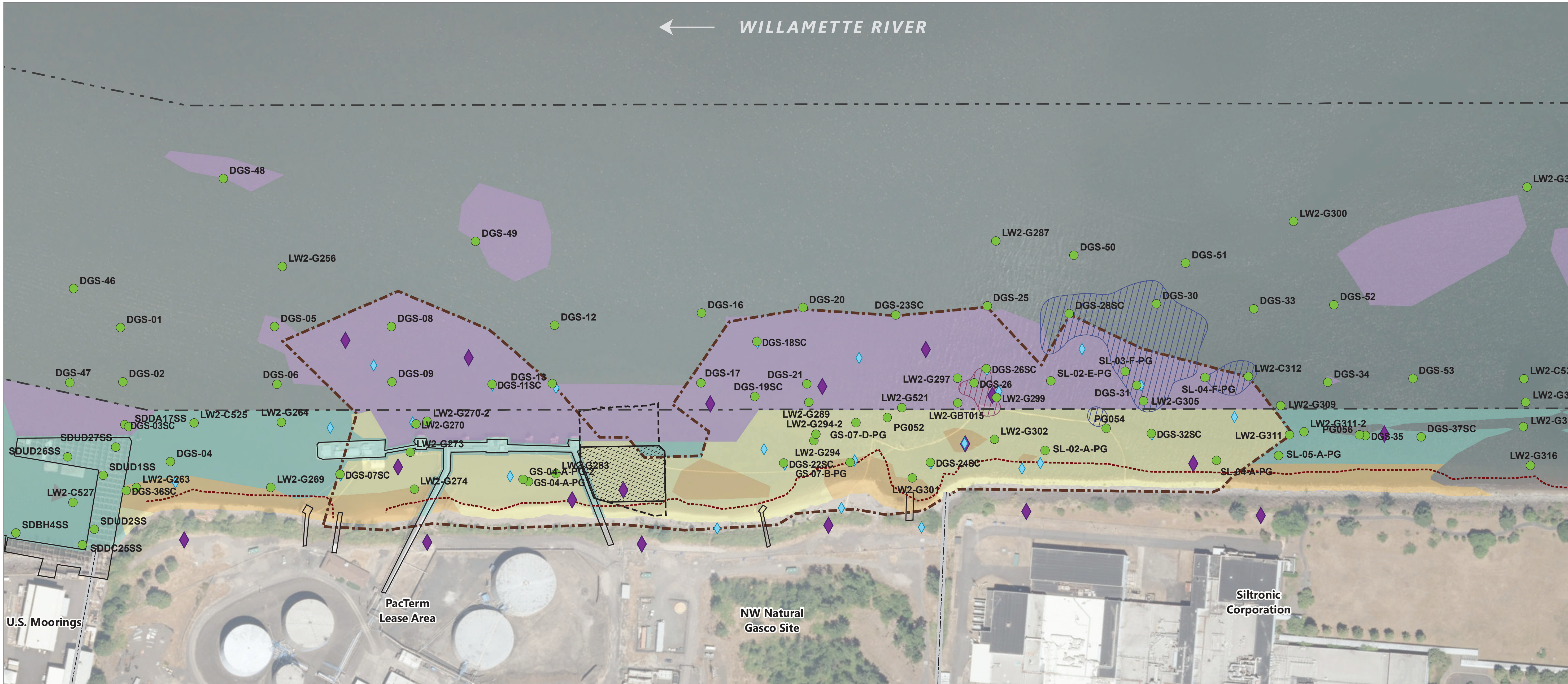
Figure 11
Surface Sediment Exceedances of Oregon DEQ's Occupational Risk-Based Concentrations for cis-1,2-DCE
Gasco Sediments Cleanup Action



LEGEND:

- Navigation Channel
- Structures
- Property Line
- Tar Body Removal Action Area (RAPP, Anchor 2005)
- Tar Body Removal Action Pilot Cap
- PTW-NAPL Boundary
- Approximate Riprap Boundary[1]

ROD SMA Technology[2]

- Cap
- Dredge
- Dredge in Nav-FMD
- Dredge with Cap
- 2010 Transition Zone Water Vinyl Chloride Area 1 Boundary (Anchor QEA 2012)[3]
- Area 2 – Detected CVOCs in TZW and One Subsurface Sediment Location[4]

- Existing TCLP Location
- Proposed TCLP/RBC Location
- Concentration is < DEQ VC Occupational RBC of 4.4 ppm
- Concentration is ≥ DEQ VC Occupational RBC of 4.4 ppm

NOTES:

1. Estimated from side scan sonar survey conducted by Blue Water Engineering April 2011.
2. All depicted SMA technology and PTW contours taken from the Portland Harbor Superfund Site Record of Decision (2017) without application of the EPA Explanation of Significant Differences (ESD; EPA 2018), which is not yet finalized.
3. Boundary taken from Draft Engineering Evaluation/Cost Analysis, Appendix A, Figure 4.2. Transition zone water screening level exceedances of cis-1,2-dichloroethene identified within this vinyl chloride boundary.
4. Boundary taken from Gasco Sediments Site Statement of Work, Figure 1 (EPA 2009).
5. The maximum concentration among all subsurface samples was compared to the Oregon DEQ's risk-based concentration of 4.4 mg/kg for Vinyl Chloride.
6. Arrow indicates direction of flow of river.
7. Horizontal datum is NAD83 (HARN 91) Oregon State Plane North, International Feet.
8. Vertical datum is City of Portland (COP), Feet.
9. Aerial imagery from City of Portland 2018.

VC: Vinyl Chloride
TCLP: toxicity characteristic leaching procedure
RBC: risk-based concentration
DEQ: Department of Environmental Quality

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Feet

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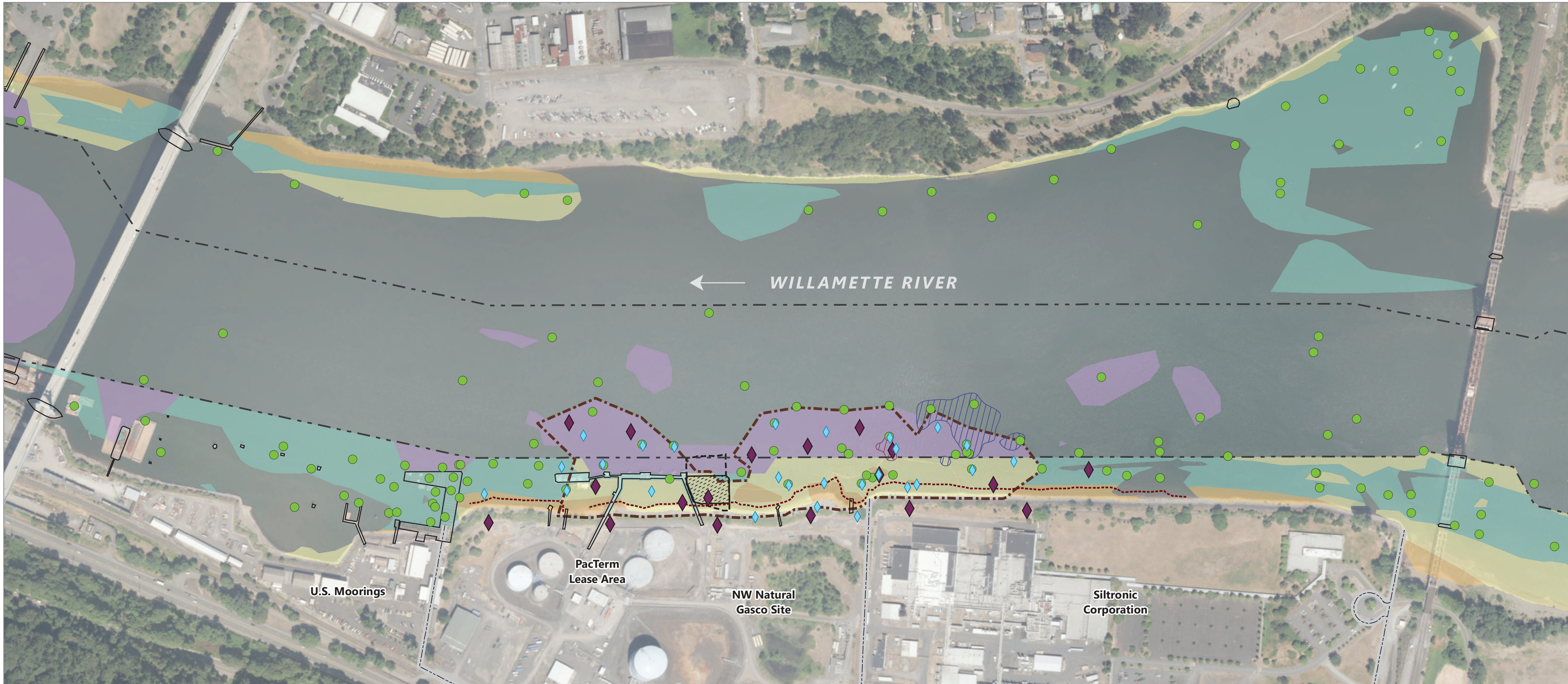
Figure 12
Surface Sediment Exceedances of Oregon DEQ's Occupational Risk-Based Concentrations for Vinyl Chloride
Gasco Sediments Cleanup Action



LEGEND:

- Navigation Channel
- Structures
- Property Line
- Tar Body Removal Action Area (RAPP, Anchor 2005)
- Tar Body Removal Action Pilot Cap
- PTW-NAPL Boundary
- Approximate Riprap Boundary[1]

ROD SMA Technology[2]

- Cap
- Dredge
- Dredge in Nav-FMD
- Dredge with Cap
- 2010 Transition Zone Water Vinyl Chloride Area 1 Boundary (Anchor QEA 2012)[3]
- Area 2 – Detected CVOCs in TZW and One Subsurface Sediment Location[4]

- Existing TCLP Location
- Proposed TCLP/RBC Location
- Concentration is < DEQ DDD Occupational RBC of 12 ppm
- Concentration is ≥ DEQ DDD Occupational RBC of 12 ppm

NOTES:

1. Estimated from side scan sonar survey conducted by Blue Water Engineering April 2011.
2. All depicted SMA technology and PTW contours taken from the Portland Harbor Superfund Site Record of Decision (2017) without application of the EPA Explanation of Significant Differences (ESD; EPA 2018), which is not yet finalized.
3. Boundary taken from Draft Engineering Evaluation/Cost Analysis, Appendix A, Figure 4.2. Transition zone water screening level exceedances of cis-1,2-dichloroethene identified within this vinyl chloride boundary.
4. Boundary taken from Gasco Sediments Site Statement of Work, Figure 1 (EPA 2009).
5. The maximum concentration among all subsurface samples was compared to the Oregon DEQ's risk-based concentration of 12 mg/kg for 4,4'-DDD.
6. Arrow indicates direction of flow of river.
7. Horizontal datum is NAD83 (HARN 91) Oregon State Plane North, International Feet.
8. Vertical datum is City of Portland (COP), Feet.
9. Aerial imagery from City of Portland 2018.

DDD: 4,4'-Dichlorodiphenyldichloroethane
TCLP: toxicity characteristic leaching procedure
RBC: risk-based concentration
DEQ: Department of Environmental Quality

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Feet

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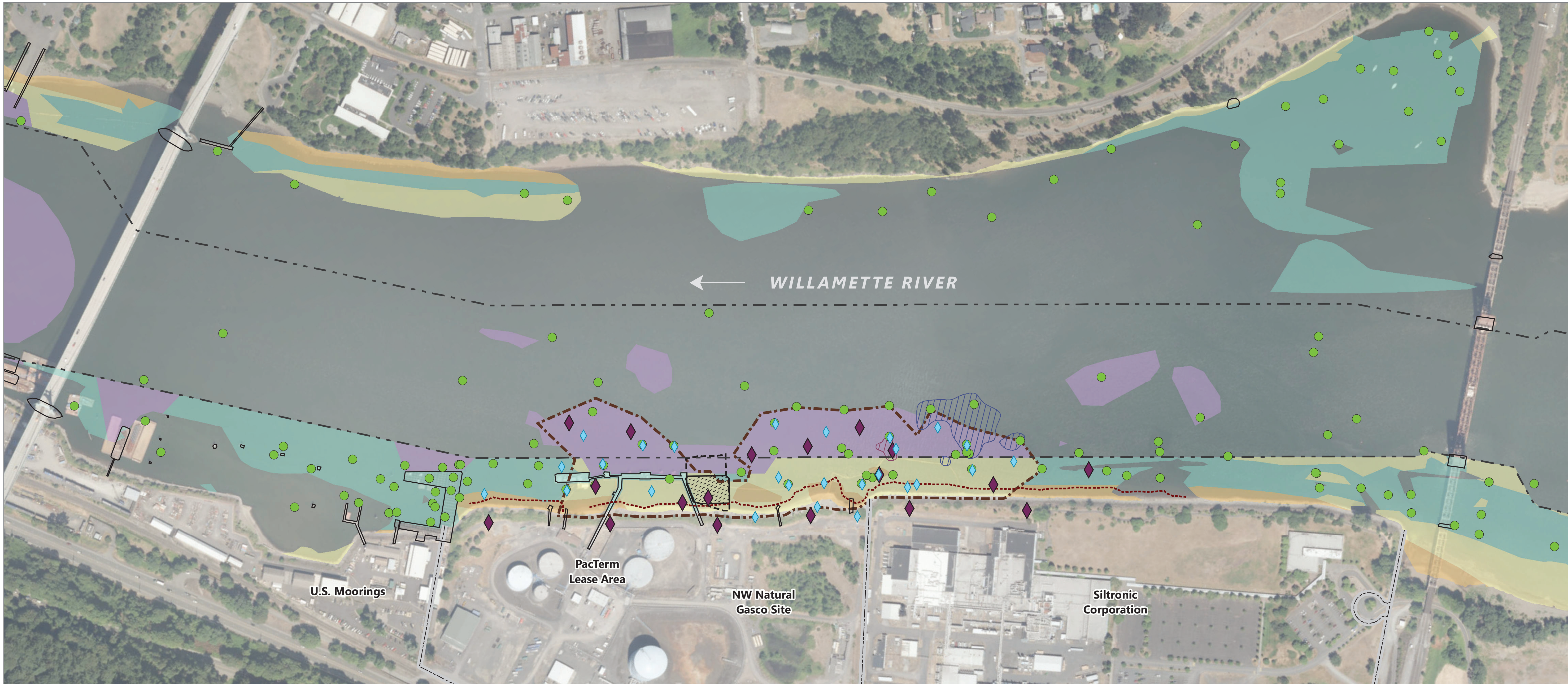
Figure 13
Subsurface Sediment Exceedances of Oregon DEQ's Occupational Risk-Based Concentrations for 4,4'-DDD
Gasco Sediments Cleanup Action



LEGEND:

Navigation Channel
Structures
Property Line
Tar Body Removal Action Area (RAPP, Anchor 2005)
Tar Body Removal Action Pilot Cap
PTW-NAPL Boundary
Approximate Riprap Boundary[1]

ROD SMA Technology[2]

Cap
Dredge
Dredge in Nav-FMD
Dredge with Cap
2010 Transition Zone Water Vinyl Chloride Area 1 Boundary (Anchor QEA 2012)[3]
Area 2 – Detected CVOCs in TZW and One Subsurface Sediment Location[4]

Existing TCLP Location
Proposed TCLP/RBC Location
Concentration is < DEQ DDE Occupational RBC of 8.2 ppm
Concentration is ≥ DEQ DDE Occupational RBC of 8.2 ppm

NOTES:

1. Estimated from side scan sonar survey conducted by Blue Water Engineering April 2011.
2. All depicted SMA technology and PTW contours taken from the Portland Harbor Superfund Site Record of Decision (2017) without application of the EPA Explanation of Significant Differences (ESD; EPA 2018), which is not yet finalized.
3. Boundary taken from Draft Engineering Evaluation/Cost Analysis, Appendix A, Figure 4.2. Transition zone water screening level exceedances of cis-1,2-dichloroethene identified within this vinyl chloride boundary.
4. Boundary taken from Gasco Sediments Site Statement of Work, Figure 1 (EPA 2009).
5. The maximum concentration among all subsurface samples was compared to the Oregon DEQ's risk-based concentration of 8.2 mg/kg for 4,4'-DDE.
6. Arrow indicates direction of flow of river.
7. Horizontal datum is NAD83 (HARN 91) Oregon State Plane North, International Feet.
8. Vertical datum is City of Portland (COP), Feet.
9. Aerial imagery from City of Portland 2018.

DDE: 4,4'-Dichlorodiphenyldichloroethene
TCLP: toxicity characteristic leaching procedure
RBC: risk-based concentration
DEQ: Department of Environmental Quality

0 400
Feet

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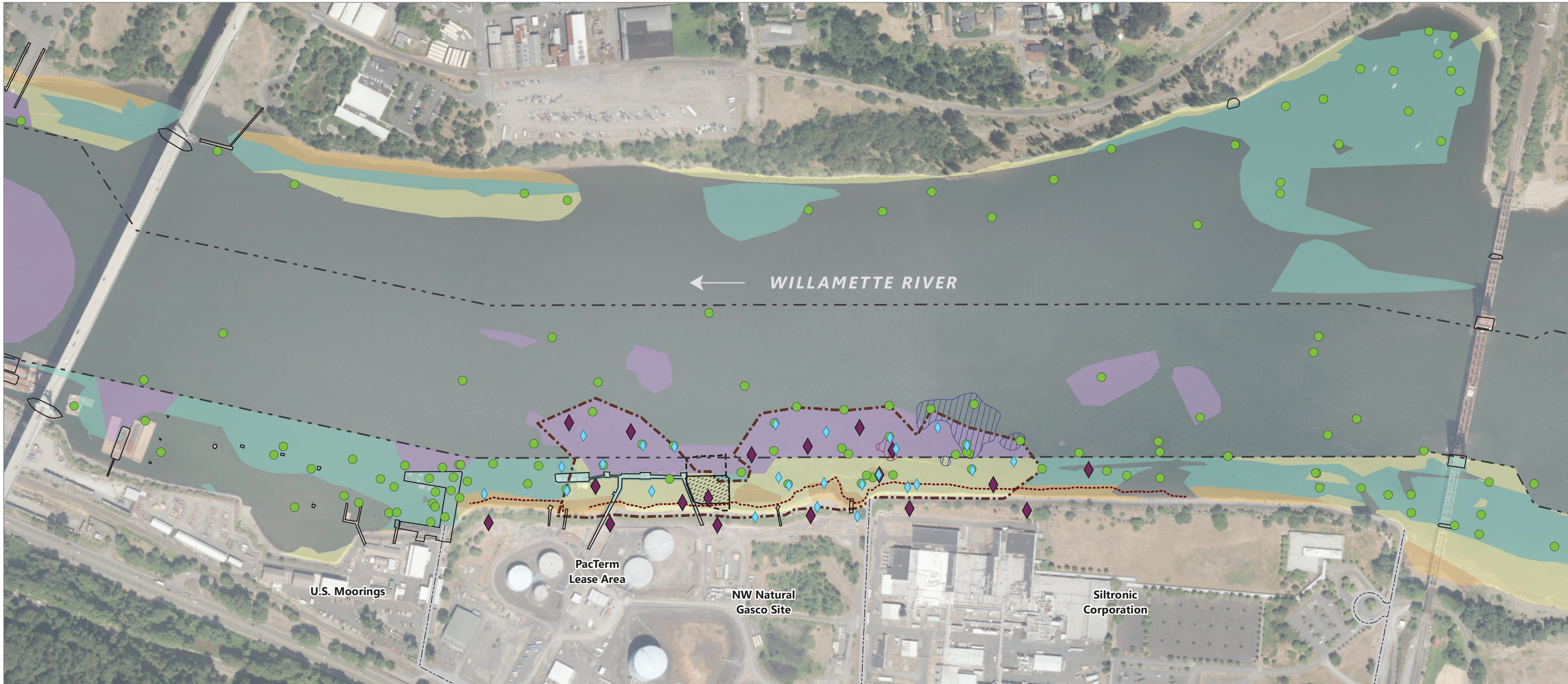
ANCHOR QEA

Figure 14
Subsurface Sediment Exceedances of Oregon DEQ's Occupational Risk-Based Concentrations for 4,4'-DDE
Gasco Sediments Cleanup Action



LEGEND:

- Navigation Channel
- Structures
- Property Line
- Tar Body Removal Action Area (RAPP, Anchor 2005)
- Tar Body Removal Action Pilot Cap
- PTW-NAPL Boundary
- Approximate Riprap Boundary[1]

ROD SMA Technology[2]

- Cap
- Dredge
- Dredge in Nav-FMD
- Dredge with Cap
- 2010 Transition Zone Water Vinyl Chloride Area 1 Boundary (Anchor QEA 2012)[3]
- Area 2 – Detected CVOCs in TZW and One Subsurface Sediment Location[4]

- Existing TCLP Location
- Proposed TCLP/RBC Location
- Concentration is < DEQ DDT Occupational RBC of 8.5 ppm
- Concentration is ≥ DEQ DDT Occupational RBC of 8.5 ppm

NOTES:

1. Estimated from side scan sonar survey conducted by Blue Water Engineering April 2011.
2. All depicted SMA technology and PTW contours taken from the Portland Harbor Superfund Site Record of Decision (2017) without application of the EPA Explanation of Significant Differences (ESD; EPA 2018), which is not yet finalized.
3. Boundary taken from Draft Engineering Evaluation/Cost Analysis, Appendix A, Figure 4.2. Transition zone water screening level exceedances of cis-1,2-dichloroethene identified within this vinyl chloride boundary.
4. Boundary taken from Gasco Sediments Site Statement of Work, Figure 1 (EPA 2009).
5. The maximum concentration among all subsurface samples was compared to the Oregon DEQ's risk-based concentration of 8.5 mg/kg for 4,4'-DDT.
6. Arrow indicates direction of flow of river.
7. Horizontal datum is NAD83 (HARN 91) Oregon State Plane North, International Feet.
8. Vertical datum is City of Portland (COP), Feet.
9. Aerial imagery from City of Portland 2018.

DDT: 4,4'-Dichlorodiphenyltrichloroethane
TCLP: toxicity characteristic leaching procedure
RBC: risk-based concentration
DEQ: Department of Environmental Quality

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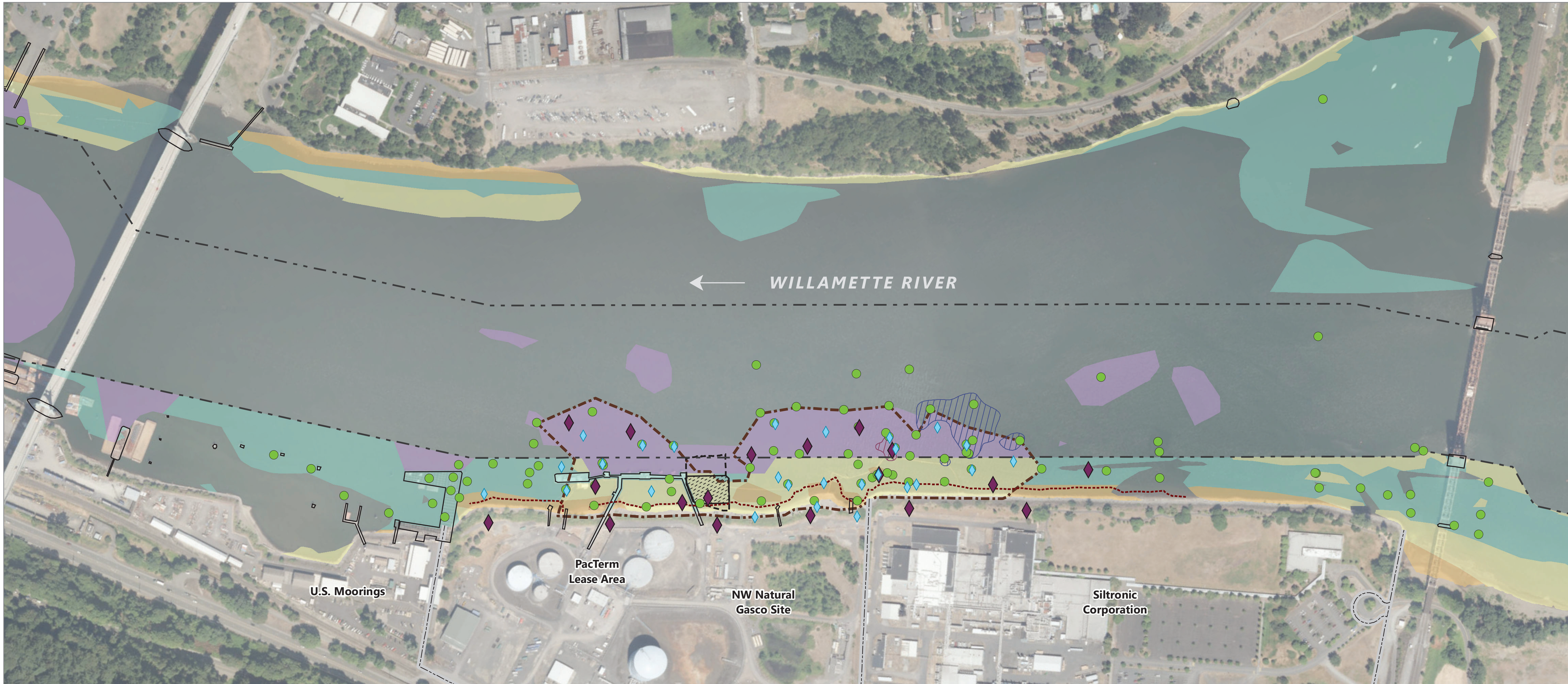
Figure 15
Subsurface Sediment Exceedances of Oregon DEQ's Occupational Risk-Based Concentrations for 4,4'-DDT
Gasco Sediments Cleanup Action



LEGEND:

- Navigation Channel
- Structures
- Property Line
- Tar Body Removal Action Area (RAPP, Anchor 2005)
- Tar Body Removal Action Pilot Cap
- PTW-NAPL Boundary
- Approximate Riprap Boundary[1]

ROD SMA Technology[2]

- Cap
- Dredge
- Dredge in Nav-FMD
- Dredge with Cap
- 2010 Transition Zone Water Vinyl Chloride Area 1 Boundary (Anchor QEA 2012)[3]
- Area 2 – Detected CVOCs in TZW and One Subsurface Sediment Location[4]

- Existing TCLP Location
- Proposed TCLP/RBC Location
- Concentration is < DEQ TCE Occupational RBC of 51 ppm
- Concentration is ≥ DEQ TCE Occupational RBC of 51 ppm

NOTES:

1. Estimated from side scan sonar survey conducted by Blue Water Engineering April 2011.
2. All depicted SMA technology and PTW contours taken from the Portland Harbor Superfund Site Record of Decision (2017) without application of the EPA Explanation of Significant Differences (ESD; EPA 2018), which is not yet finalized.
3. Boundary taken from Draft Engineering Evaluation/Cost Analysis, Appendix A, Figure 4.2. Transition zone water screening level exceedances of cis-1,2-dichloroethene identified within this vinyl chloride boundary.
4. Boundary taken from Gasco Sediments Site Statement of Work, Figure 1 (EPA 2009).
5. The maximum concentration among all subsurface samples was compared to the Oregon DEQ's risk-based concentration of 51 mg/kg for TCE.
6. Arrow indicates direction of flow of river.
7. Horizontal datum is NAD83 (HARN 91) Oregon State Plane North, International Feet.
8. Vertical datum is City of Portland (COP), Feet.
9. Aerial imagery from City of Portland 2018.

TCE: trichloroethene
TCLP: toxicity characteristic leaching procedure
RBC: risk-based concentration
DEQ: Department of Environmental Quality

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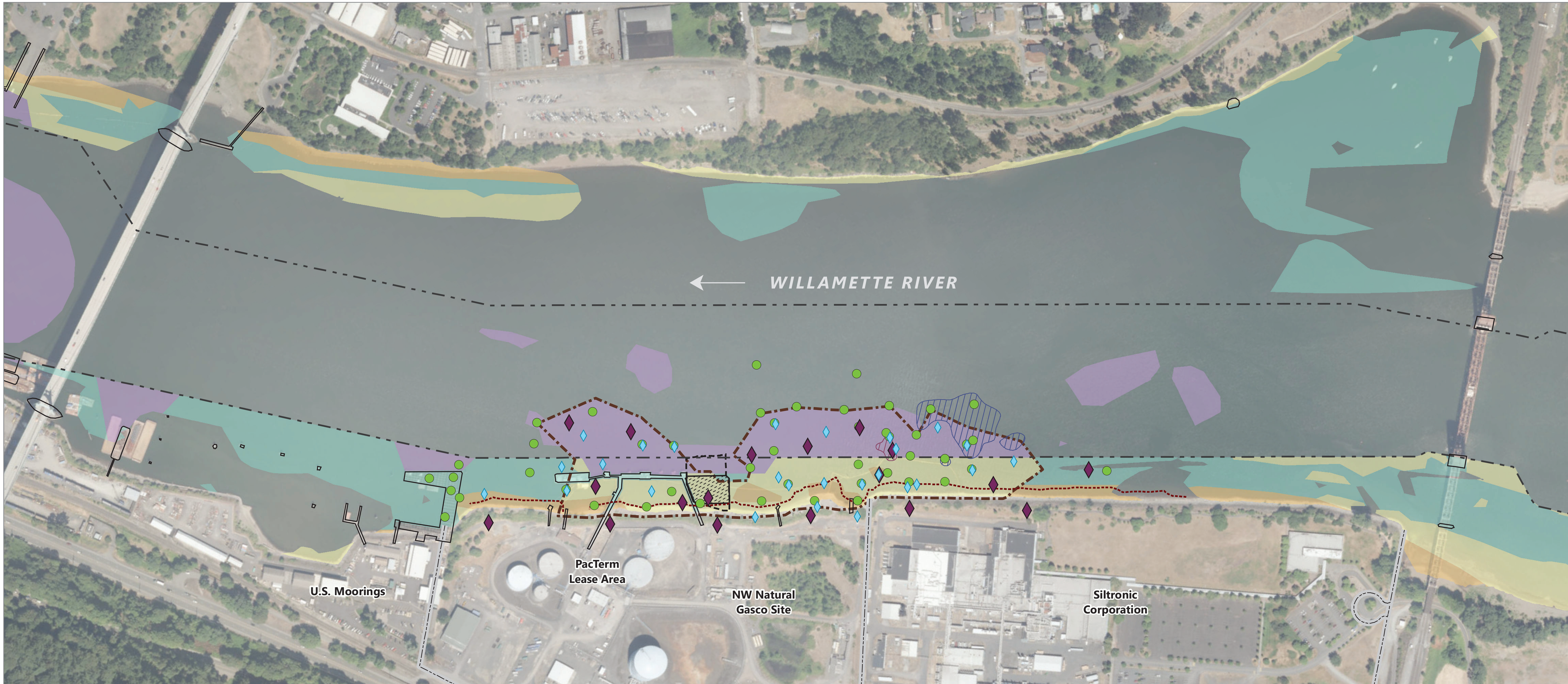
ANCHOR QEA

Figure 16
Subsurface Sediment Exceedances of Oregon DEQ's Occupational Risk-Based Concentrations for TCE
Gasco Sediments Cleanup Action



LEGEND:

- Navigation Channel
- Structures
- Property Line
- Tar Body Removal Action Area (RAPP, Anchor 2005)
- Tar Body Removal Action Pilot Cap
- PTW-NAPL Boundary
- Approximate Riprap Boundary[1]

ROD SMA Technology[2]

- Cap
- Dredge
- Dredge in Nav-FMD
- Dredge with Cap
- 2010 Transition Zone Water Vinyl Chloride Area 1 Boundary (Anchor QEA 2012)[3]
- Area 2 – Detected CVOCs in TZW and One Subsurface Sediment Location[4]

- Existing TCLP Location
- Proposed TCLP/RBC Location
- Concentration is < DEQ DCE Occupational RBC of 2,300 ppm
- Concentration is ≥ DEQ DCE Occupational RBC of 2,300 ppm

NOTES:

1. Estimated from side scan sonar survey conducted by Blue Water Engineering April 2011.
2. All depicted SMA technology and PTW contours taken from the Portland Harbor Superfund Site Record of Decision (2017) without application of the EPA Explanation of Significant Differences (ESD; EPA 2018), which is not yet finalized.
3. Boundary taken from Draft Engineering Evaluation/Cost Analysis, Appendix A, Figure 4.2. Transition zone water screening level exceedances of cis-1,2-dichloroethene identified within this vinyl chloride boundary.
4. Boundary taken from Gasco Sediments Site Statement of Work, Figure 1 (EPA 2009).
5. The maximum concentration among all subsurface samples was compared to the Oregon DEQ's risk-based concentration of 2,300 mg/kg for cis-1,2-DCE .
6. Arrow indicates direction of flow of river.
7. Horizontal datum is NAD83 (HARN 91) Oregon State Plane North, International Feet.
8. Vertical datum is City of Portland (COP), Feet.
9. Aerial imagery from City of Portland 2018.

cis-1,2-DCE: cis-1,2-Dichloroethene
TCLP: toxicity characteristic leaching procedure
RBC: risk-based concentration
DEQ: Department of Environmental Quality

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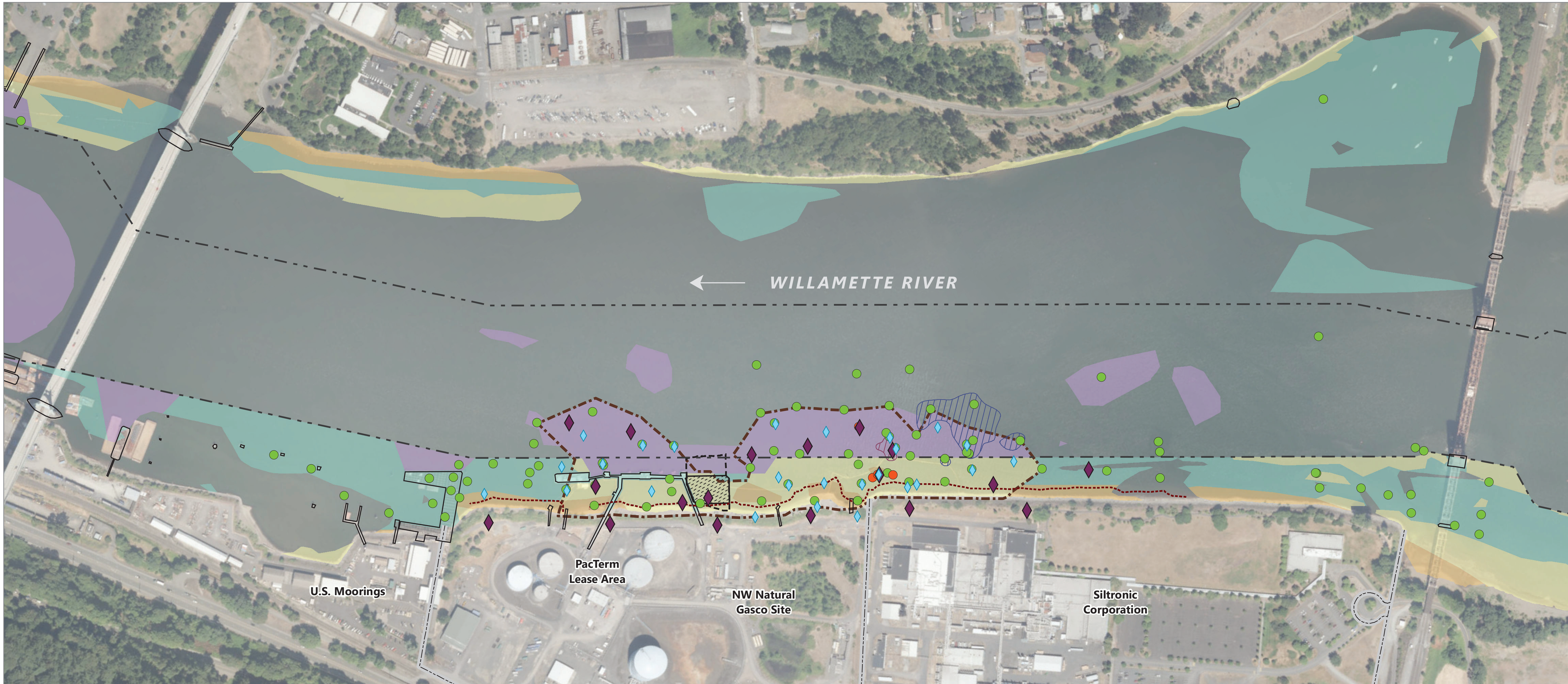
ANCHOR QEA

Figure 17
Subsurface Sediment Exceedances of Oregon DEQ's Occupational Risk-Based Concentrations for cis-1,2-DCE
Gasco Sediments Cleanup Action



LEGEND:

- Navigation Channel
- Structures
- Property Line
- Tar Body Removal Action Area (RAPP, Anchor 2005)
- Tar Body Removal Action Pilot Cap
- PTW-NAPL Boundary
- Approximate Riprap Boundary[1]

ROD SMA Technology[2]

- Cap
- Dredge
- Dredge in Nav-FMD
- Dredge with Cap
- 2010 Transition Zone Water Vinyl Chloride Area 1 Boundary (Anchor QEA 2012)[3]
- Area 2 – Detected CVOCs in TZW and One Subsurface Sediment Location[4]

- Existing TCLP Location
- Proposed TCLP/RBC Location
- Concentration is < DEQ VC Occupational RBC of 4.4 ppm
- Concentration is ≥ DEQ VC Occupational RBC of 4.4 ppm

NOTES:

1. Estimated from side scan sonar survey conducted by Blue Water Engineering April 2011.
2. All depicted SMA technology and PTW contours taken from the Portland Harbor Superfund Site Record of Decision (2017) without application of the EPA Explanation of Significant Differences (ESD; EPA 2018), which is not yet finalized.
3. Boundary taken from Draft Engineering Evaluation/Cost Analysis, Appendix A, Figure 4.2. Transition zone water screening level exceedances of cis-1,2-dichloroethene identified within this vinyl chloride boundary.
4. Boundary taken from Gasco Sediments Site Statement of Work, Figure 1 (EPA 2009).
5. The maximum concentration among all subsurface samples was compared to the Oregon DEQ's risk-based concentration of 4.4 mg/kg for Vinyl Chloride.
6. Arrow indicates direction of flow of river.
7. Horizontal datum is NAD83 (HARN 91) Oregon State Plane North, International Feet.
8. Vertical datum is City of Portland (COP), Feet.
9. Aerial imagery from City of Portland 2018.

VC: Vinyl Chloride
TCLP: toxicity characteristic leaching procedure
RBC: risk-based concentration
DEQ: Department of Environmental Quality

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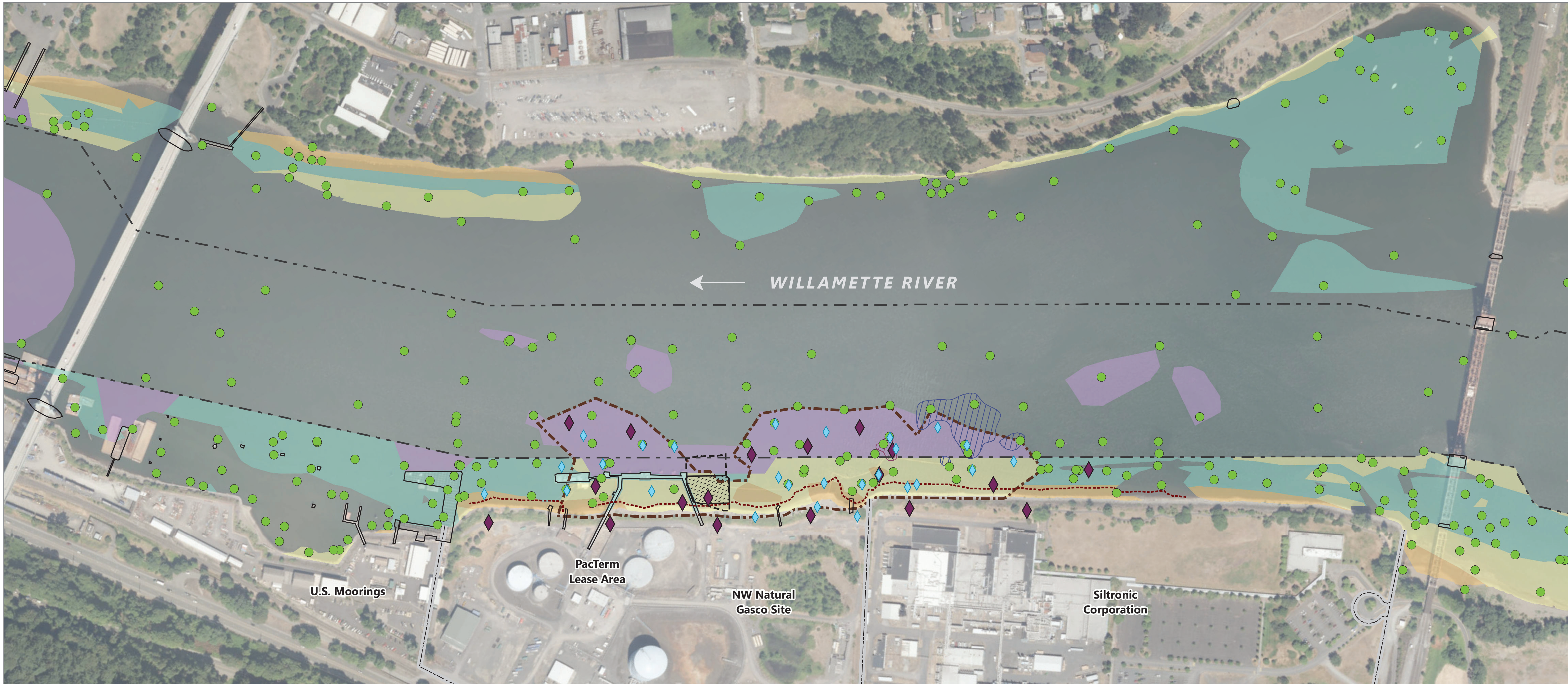
Figure 18
Subsurface Sediment Exceedances of Oregon DEQ's Occupational Risk-Based Concentrations for Vinyl Chloride
Gasco Sediments Cleanup Action



LEGEND:

- Navigation Channel
- Structures
- Property Line
- Tar Body Removal Action Area (RAPP, Anchor 2005)
- Tar Body Removal Action Pilot Cap
- PTW-NAPL Boundary
- Approximate Riprap Boundary[1]

ROD SMA Technology[2]

- Cap
- Dredge
- Dredge in Nav-FMD
- Dredge with Cap
- 2010 Transition Zone Water Vinyl Chloride Area 1 Boundary (Anchor QEA 2012)[3]
- Area 2 – Detected CVOCs in TZW and One Subsurface Sediment Location[4]

- Existing TCLP Location
- Proposed TCLP/RBC Location
- Concentration is < DEQ DDD Occupational RBC of 12 ppm
- Concentration is ≥ DEQ DDD Occupational RBC of 12 ppm

NOTES:

1. Estimated from side scan sonar survey conducted by Blue Water Engineering April 2011.
2. All depicted SMA technology and PTW contours taken from the Portland Harbor Superfund Site Record of Decision (2017) without application of the EPA Explanation of Significant Differences (ESD; EPA 2018), which is not yet finalized.
3. Boundary taken from Draft Engineering Evaluation/Cost Analysis, Appendix A, Figure 4.2. Transition zone water screening level exceedances of cis-1,2-dichloroethene identified within this vinyl chloride boundary.
4. Boundary taken from Gasco Sediments Site Statement of Work, Figure 1 (EPA 2009).
5. The maximum concentration among all subsurface samples was compared to the Oregon DEQ's risk-based concentration of 12 mg/kg for 4,4'-DDD.
6. Arrow indicates direction of flow of river.
7. Horizontal datum is NAD83 (HARN 91) Oregon State Plane North, International Feet.
8. Vertical datum is City of Portland (COP), Feet.
9. Aerial imagery from City of Portland 2018.

DDD: 4,4'-Dichlorodiphenyldichloroethane
TCLP: toxicity characteristic leaching procedure
RBC: risk-based concentration
DEQ: Department of Environmental Quality

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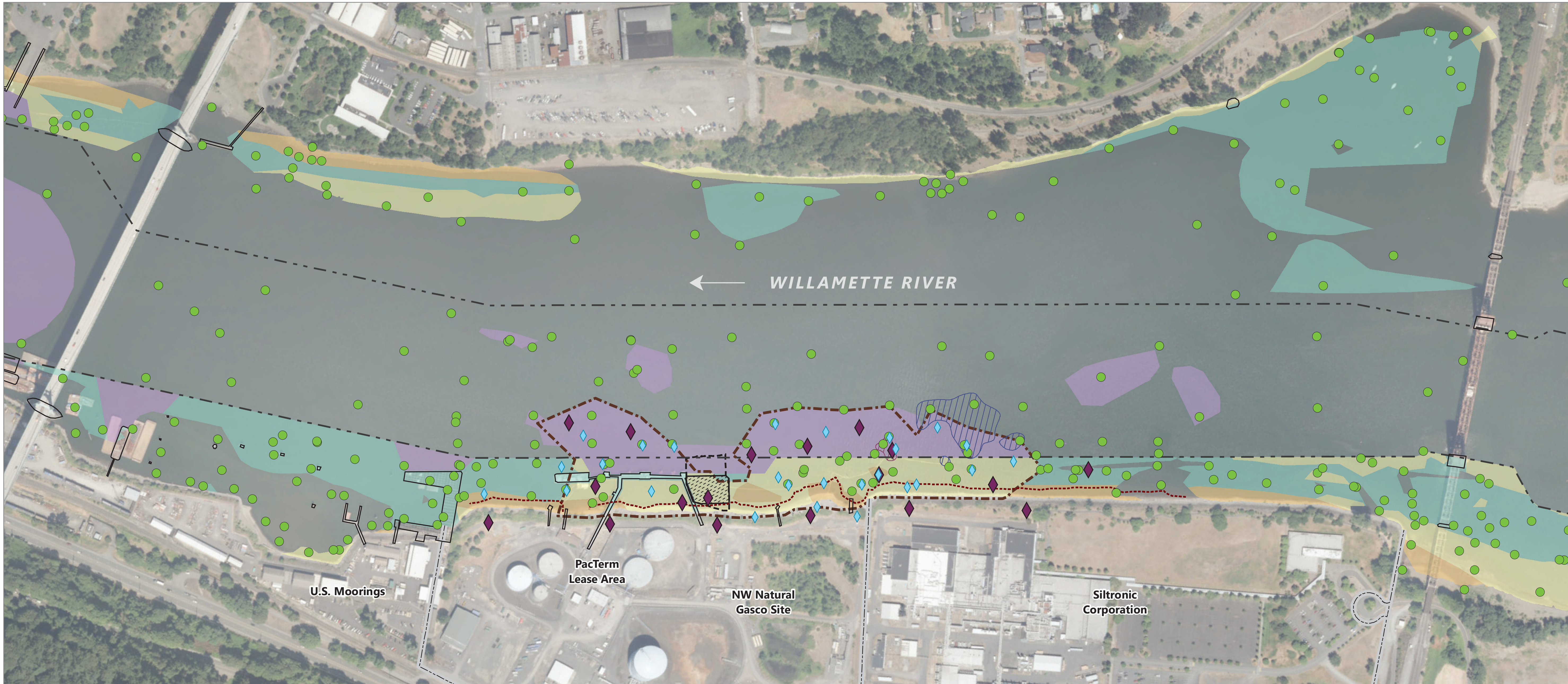
Figure 19
Surface Sediment Exceedances of Oregon DEQ's Occupational Risk-Based Concentrations for 4,4'-DDD
Gasco Sediments Cleanup Action



LEGEND:

- Navigation Channel
- Structures
- Property Line
- Tar Body Removal Action Area (RAPP, Anchor 2005)
- Tar Body Removal Action Pilot Cap
- PTW-NAPL Boundary
- Approximate Riprap Boundary[1]

ROD SMA Technology[2]

- Cap
- Dredge
- Dredge in Nav-FMD
- Dredge with Cap
- 2010 Transition Zone Water Vinyl Chloride Area 1 Boundary (Anchor QEA 2012)[3]
- Area 2 – Detected CVOCs in TZW and One Subsurface Sediment Location[4]

- Existing TCLP Location
- Proposed TCLP/RBC Location
- Concentration is < DEQ DDE Occupational RBC of 8.2 ppm
- Concentration is ≥ DEQ DDE Occupational RBC of 8.2 ppm

NOTES:

1. Estimated from side scan sonar survey conducted by Blue Water Engineering April 2011.
2. All depicted SMA technology and PTW contours taken from the Portland Harbor Superfund Site Record of Decision (2017) without application of the EPA Explanation of Significant Differences (ESD; EPA 2018), which is not yet finalized.
3. Boundary taken from Draft Engineering Evaluation/Cost Analysis, Appendix A, Figure 4.2. Transition zone water screening level exceedances of cis-1,2-dichloroethene identified within this vinyl chloride boundary.
4. Boundary taken from Gasco Sediments Site Statement of Work, Figure 1 (EPA 2009).
5. The maximum concentration among all subsurface samples was compared to the Oregon DEQ's risk-based concentration of 8.2 mg/kg for 4,4'-DDE.
6. Arrow indicates direction of flow of river.
7. Horizontal datum is NAD83 (HARN 91) Oregon State Plane North, International Feet.
8. Vertical datum is City of Portland (COP), Feet.
9. Aerial imagery from City of Portland 2018.

DDE: 4,4'-Dichlorodiphenyldichloroethene
TCLP: toxicity characteristic leaching procedure
RBC: risk-based concentration
DEQ: Department of Environmental Quality

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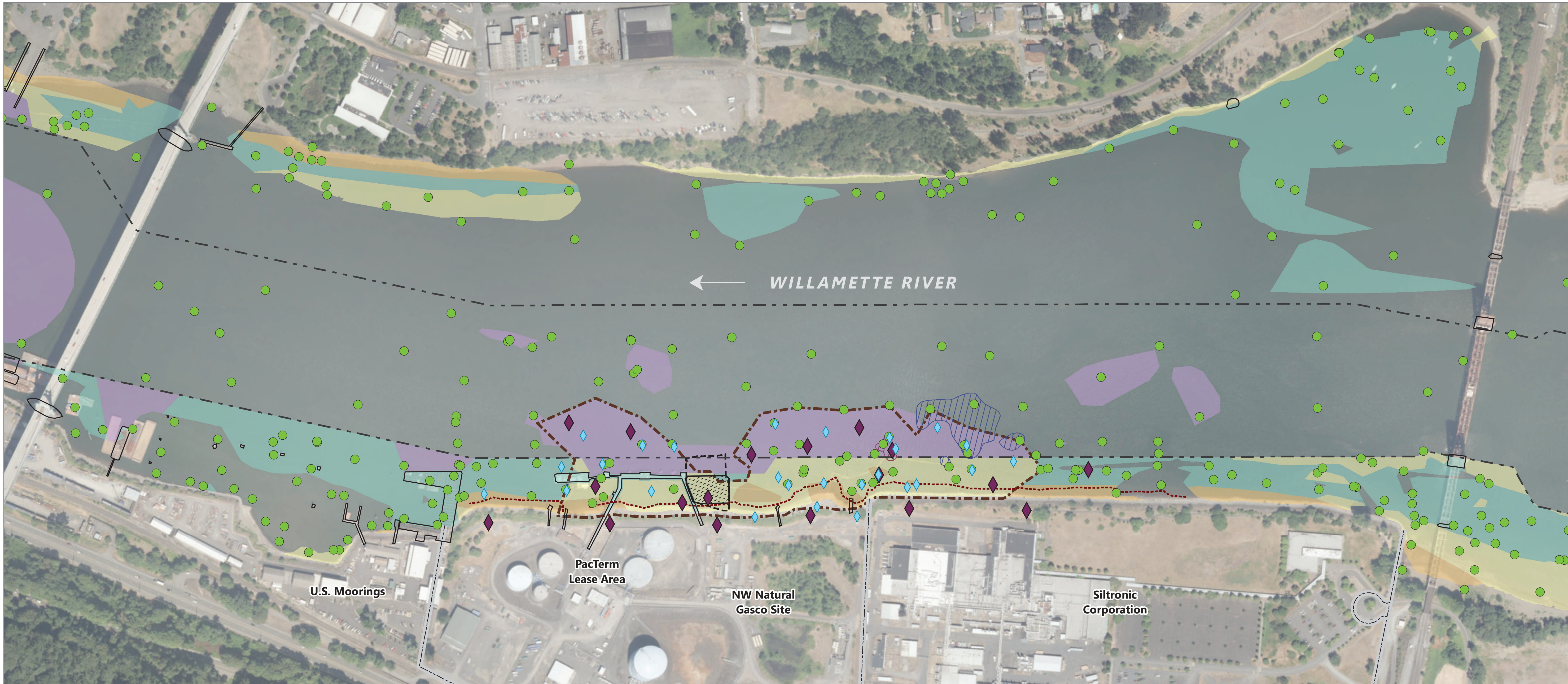
Figure 20
Surface Sediment Exceedances of Oregon DEQ's Occupational Risk-Based Concentrations for 4,4'-DDE
Gasco Sediments Cleanup Action



LEGEND:

- Navigation Channel
- Structures
- Property Line
- Tar Body Removal Action Area (RAPP, Anchor 2005)
- Tar Body Removal Action Pilot Cap
- PTW-NAPL Boundary
- Approximate Riprap Boundary[1]

ROD SMA Technology[2]

- Cap
- Dredge
- Dredge in Nav-FMD
- Dredge with Cap
- 2010 Transition Zone Water Vinyl Chloride Area 1 Boundary (Anchor QEA 2012)[3]
- Area 2 – Detected CVOCs in TZW and One Subsurface Sediment Location[4]

- Existing TCLP Location
- Proposed TCLP/RBC Location
- Concentration is < DEQ DDT Occupational RBC of 8.5 ppm
- Concentration is ≥ DEQ DDT Occupational RBC of 8.5 ppm

NOTES:

1. Estimated from side scan sonar survey conducted by Blue Water Engineering April 2011.
2. All depicted SMA technology and PTW contours taken from the Portland Harbor Superfund Site Record of Decision (2017) without application of the EPA Explanation of Significant Differences (ESD; EPA 2018), which is not yet finalized.
3. Boundary taken from Draft Engineering Evaluation/Cost Analysis, Appendix A, Figure 4.2. Transition zone water screening level exceedances of cis-1,2-dichloroethene identified within this vinyl chloride boundary.
4. Boundary taken from Gasco Sediments Site Statement of Work, Figure 1 (EPA 2009).
5. The maximum concentration among all subsurface samples was compared to the Oregon DEQ's risk-based concentration of 8.5 mg/kg for 4,4'-DDT.
6. Arrow indicates direction of flow of river.
7. Horizontal datum is NAD83 (HARN 91) Oregon State Plane North, International Feet.
8. Vertical datum is City of Portland (COP), Feet.
9. Aerial imagery from City of Portland 2018.

DDT: 4,4'-Dichlorodiphenyltrichloroethane
TCLP: toxicity characteristic leaching procedure
RBC: risk-based concentration
DEQ: Department of Environmental Quality

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Feet

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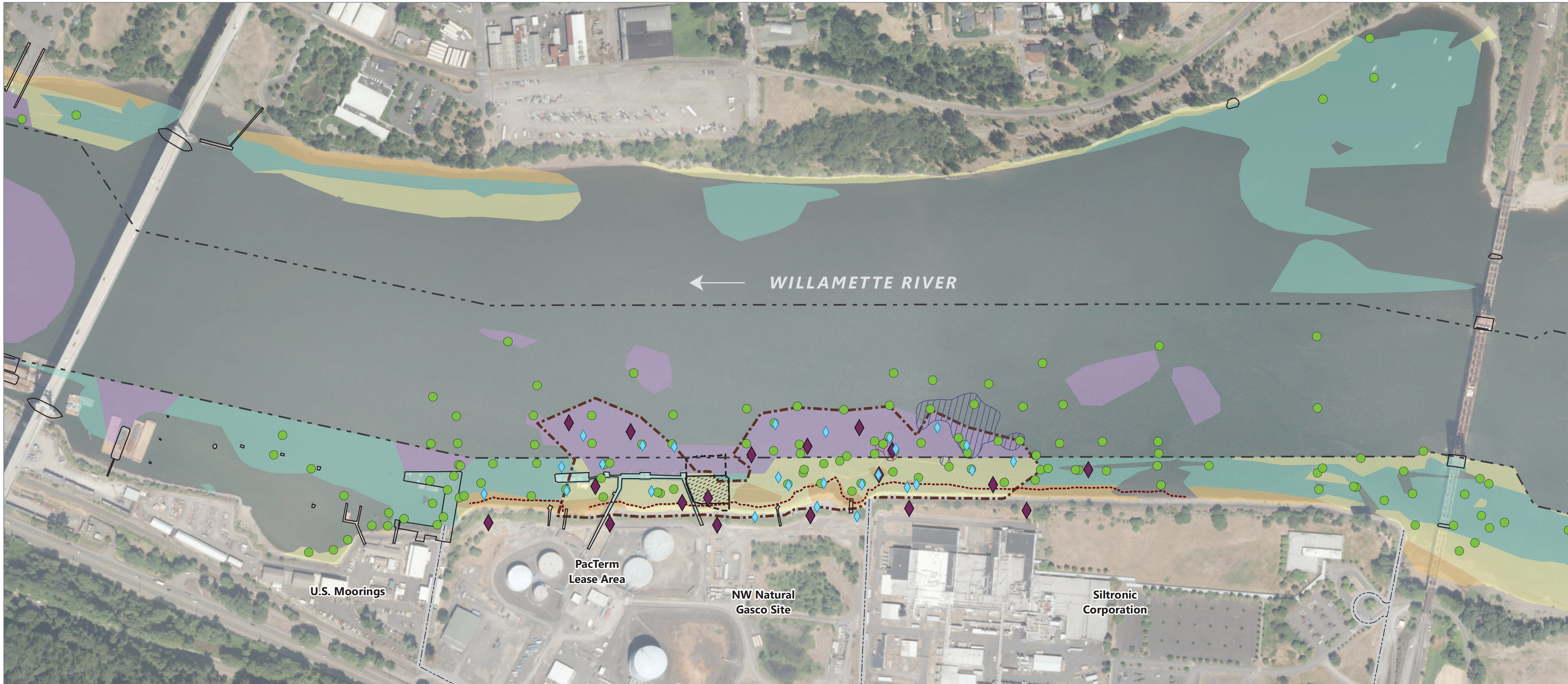
Figure 21
Surface Sediment Exceedances of Oregon DEQ's Occupational Risk-Based Concentrations for 4,4'-DDT
Gasco Sediments Cleanup Action



LEGEND:

- Navigation Channel
- Structures
- Property Line
- Tar Body Removal Action Area (RAPP, Anchor 2005)
- Tar Body Removal Action Pilot Cap
- PTW-NAPL Boundary
- Approximate Riprap Boundary[1]

ROD SMA Technology[2]

- Cap
- Dredge
- Dredge in Nav-FMD
- Dredge with Cap
- 2010 Transition Zone Water Vinyl Chloride Area 1 Boundary (Anchor QEA 2012)[3]
- Area 2 – Detected CVOCs in TZW and One Subsurface Sediment Location[4]

- Existing TCLP Location
- Proposed TCLP/RBC Location
- Concentration is < DEQ TCE Occupational RBC of 51 ppm
- Concentration is ≥ DEQ TCE Occupational RBC of 51 ppm

NOTES:

1. Estimated from side scan sonar survey conducted by Blue Water Engineering April 2011.
2. All depicted SMA technology and PTW contours taken from the Portland Harbor Superfund Site Record of Decision (2017) without application of the EPA Explanation of Significant Differences (ESD; EPA 2018), which is not yet finalized.
3. Boundary taken from Draft Engineering Evaluation/Cost Analysis, Appendix A, Figure 4.2. Transition zone water screening level exceedances of cis-1,2-dichloroethene identified within this vinyl chloride boundary.
4. Boundary taken from Gasco Sediments Site Statement of Work, Figure 1 (EPA 2009).
5. The maximum concentration among all subsurface samples was compared to the Oregon DEQ's risk-based concentration of 51 mg/kg for TCE.
6. Arrow indicates direction of flow of river.
7. Horizontal datum is NAD83 (HARN 91) Oregon State Plane North, International Feet.
8. Vertical datum is City of Portland (COP), Feet.
9. Aerial imagery from City of Portland 2018.

TCE: trichloroethene
TCLP: toxicity characteristic leaching procedure
RBC: risk-based concentration
DEQ: Department of Environmental Quality

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Feet

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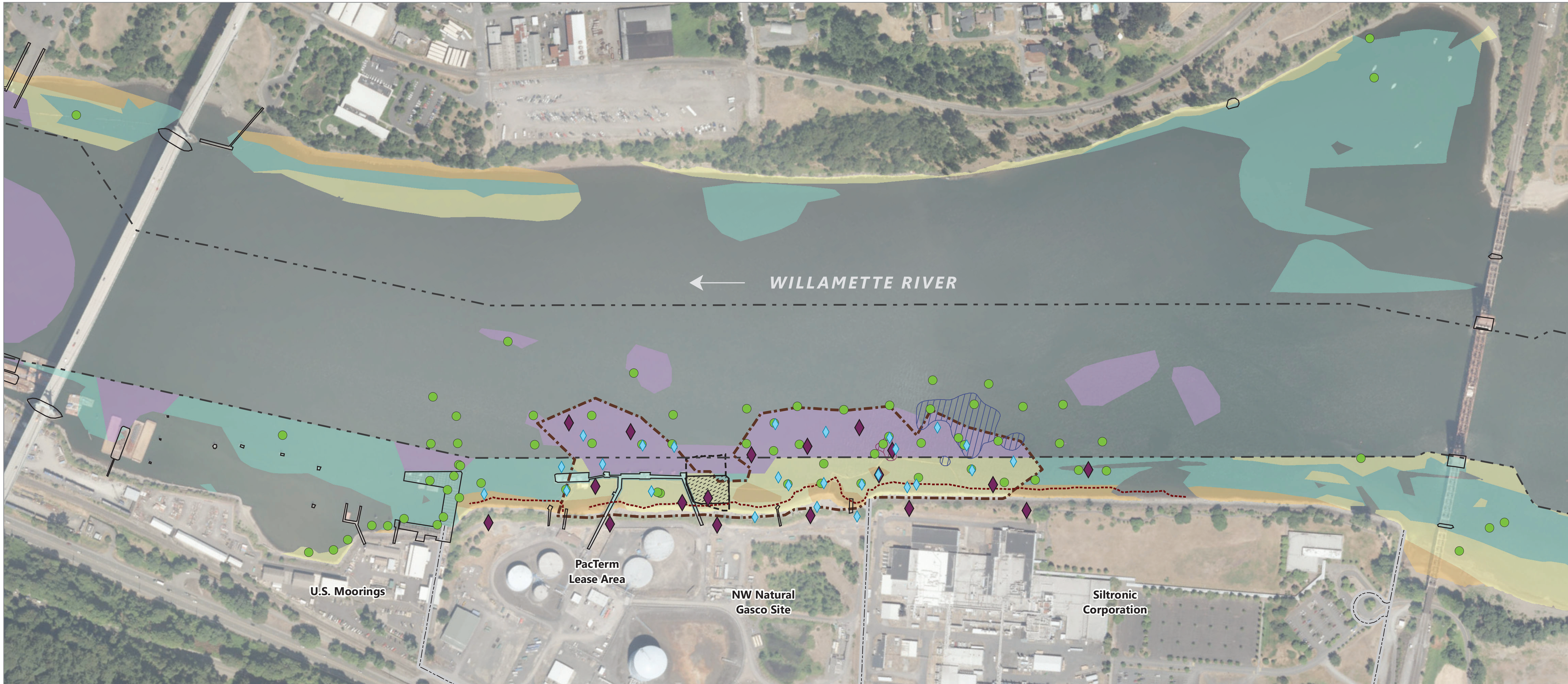
ANCHOR QEA

Figure 22
Surface Sediment Exceedances of Oregon DEQ's Occupational Risk-Based Concentrations for TCE
Gasco Sediments Cleanup Action



LEGEND:

- Navigation Channel
- Structures
- Property Line
- Tar Body Removal Action Area (RAPP, Anchor 2005)
- Tar Body Removal Action Pilot Cap
- PTW-NAPL Boundary
- Approximate Riprap Boundary[1]

ROD SMA Technology[2]

- Cap
- Dredge
- Dredge in Nav-FMD
- Dredge with Cap
- 2010 Transition Zone Water Vinyl Chloride Area 1 Boundary (Anchor QEA 2012)[3]
- Area 2 – Detected CVOCs in TZW and One Subsurface Sediment Location[4]

- Existing TCLP Location
- Proposed TCLP/RBC Location
- Concentration is < DEQ DCE Occupational RBC of 2,300 ppm
- Concentration is ≥ DEQ DCE Occupational RBC of 2,300 ppm

NOTES:

1. Estimated from side scan sonar survey conducted by Blue Water Engineering April 2011.
2. All depicted SMA technology and PTW contours taken from the Portland Harbor Superfund Site Record of Decision (2017) without application of the EPA Explanation of Significant Differences (ESD; EPA 2018), which is not yet finalized.
3. Boundary taken from Draft Engineering Evaluation/Cost Analysis, Appendix A, Figure 4.2. Transition zone water screening level exceedances of cis-1,2-dichloroethene identified within this vinyl chloride boundary.
4. Boundary taken from Gasco Sediments Site Statement of Work, Figure 1 (EPA 2009).
5. The maximum concentration among all subsurface samples was compared to the Oregon DEQ's risk-based concentration of 2,300 mg/kg for cis-1,2-DCE .
6. Arrow indicates direction of flow of river.
7. Horizontal datum is NAD83 (HARN 91) Oregon State Plane North, International Feet.
8. Vertical datum is City of Portland (COP), Feet.
9. Aerial imagery from City of Portland 2018.

cis-1,2-DCE: cis-1,2-Dichloroethene
TCLP: toxicity characteristic leaching procedure
RBC: risk-based concentration
DEQ: Department of Environmental Quality

0 400
Feet

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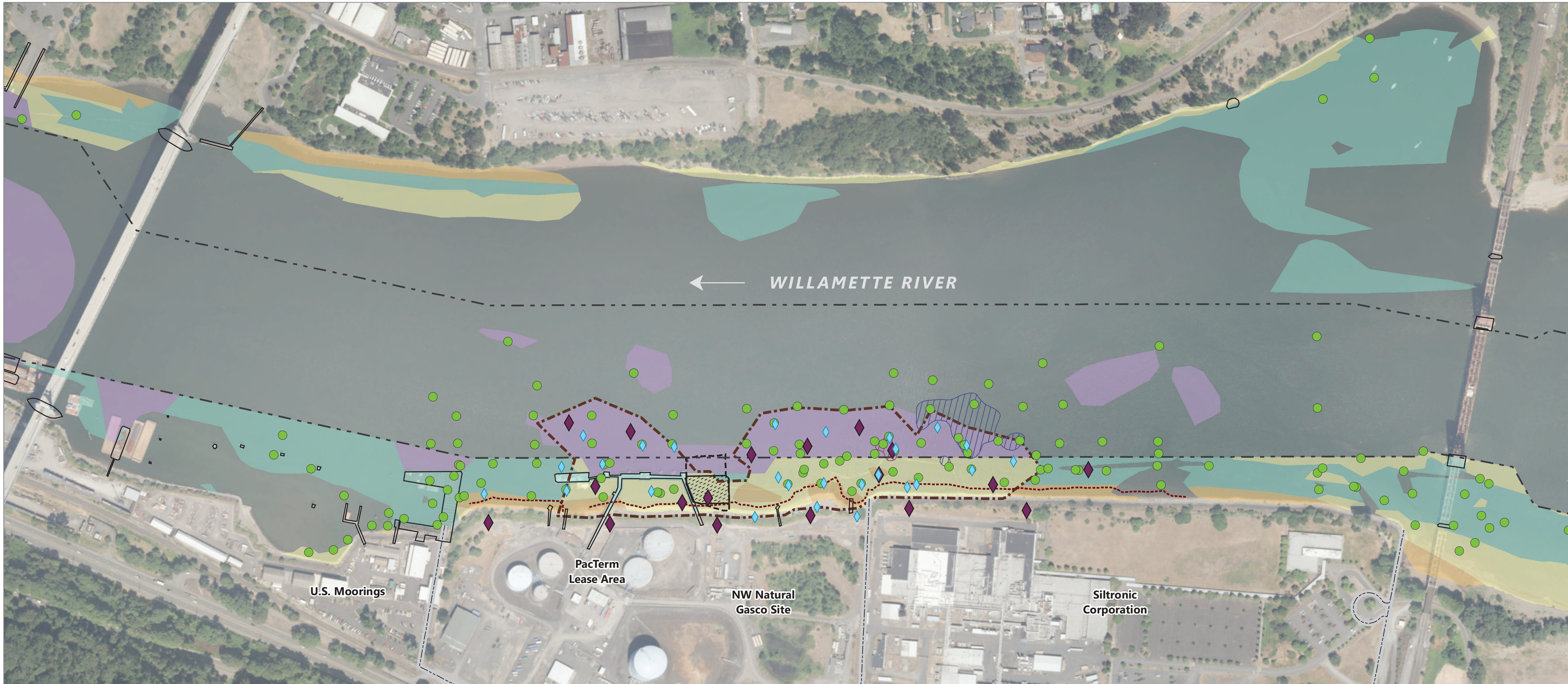
Figure 23
Surface Sediment Exceedances of Oregon DEQ's Occupational Risk-Based Concentrations for cis-1,2-DCE
Gasco Sediments Cleanup Action



LEGEND:

- Navigation Channel
- Structures
- Property Line
- Tar Body Removal Action Area (RAPP, Anchor 2005)
- Tar Body Removal Action Pilot Cap
- PTW-NAPL Boundary
- Approximate Riprap Boundary[1]

ROD SMA Technology[2]

- Cap
- Dredge
- Dredge in Nav-FMD
- Dredge with Cap
- 2010 Transition Zone Water Vinyl Chloride Area 1 Boundary (Anchor QEA 2012)[3]
- Area 2 – Detected CVOCs in TZW and One Subsurface Sediment Location[4]

- Existing TCLP Location
- Proposed TCLP/RBC Location
- Concentration is < DEQ VC Occupational RBC of 4.4 ppm
- Concentration is ≥ DEQ VC Occupational RBC of 4.4 ppm

NOTES:

1. Estimated from side scan sonar survey conducted by Blue Water Engineering April 2011.
2. All depicted SMA technology and PTW contours taken from the Portland Harbor Superfund Site Record of Decision (2017) without application of the EPA Explanation of Significant Differences (ESD; EPA 2018), which is not yet finalized.
3. Boundary taken from Draft Engineering Evaluation/Cost Analysis, Appendix A, Figure 4.2. Transition zone water screening level exceedances of cis-1,2-dichloroethene identified within this vinyl chloride boundary.
4. Boundary taken from Gasco Sediments Site Statement of Work, Figure 1 (EPA 2009).
5. The maximum concentration among all subsurface samples was compared to the Oregon DEQ's risk-based concentration of 4.4 mg/kg for Vinyl Chloride.
6. Arrow indicates direction of flow of river.
7. Horizontal datum is NAD83 (HARN 91) Oregon State Plane North, International Feet.
8. Vertical datum is City of Portland (COP), Feet.
9. Aerial imagery from City of Portland 2018.

VC: Vinyl Chloride
TCLP: toxicity characteristic leaching procedure
RBC: risk-based concentration
DEQ: Department of Environmental Quality

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ANCHOR QEA

Figure 24
Surface Sediment Exceedances of Oregon DEQ's Occupational Risk-Based Concentrations for Vinyl Chloride
Gasco Sediments Cleanup Action

Appendix K-2
NW Natural Response to EPA Conditional Approval Letter on the Gasco Sediments Site TEWP, DGWP, and Capping Approach

6720 SW Macadam Avenue, Suite 125
Portland, Oregon 97219
503.670.1108

Memorandum

September 11, 2019

To: Sean Sheldrake and Karl Gustavson, U.S. Environmental Protection Agency

From: Ryan Barth, PE, Anchor QEA, LLC

cc: Bob Wyatt, NW Natural
Patty Dost, Pearl Legal Group
Lance Peterson, CDM Smith
Dana Bayuk, Oregon Department of Environmental Quality
Paul Schroeder, U.S. Army Corps of Engineers
Myron Burr, Siltronic Corporation
Michael Murray, Maul Foster & Alongi

Re: NW Natural Response to EPA Conditional Approval Letter on the Gasco Sediments Site TEWP, DGWP, and Capping Approach

On September 6, 2019, the U.S. Environmental Protection Agency (EPA) provided NW Natural conditional approval of the *Final Pre-Remedial Basis of Design Technical Evaluations Work Plan* (TEWP) dated August 29, 2019, the *Revised Pre-Remedial Design Data Gaps Work Plan* (DGWP) dated August 22, 2019, and the *Summary of Final Cap Modeling and Long-Term Cap Monitoring Approach – Gasco Sediments Site* (Capping Approach) dated June 25, 2019, and presented as TEWP Appendix H. This memorandum provides NW Natural's responses to EPA's conditional approval letter (Attachment A). NW Natural is separately submitting a final revised version of the DGWP in accordance with the conditional approval requirements, and this memorandum is included in DGWP Appendix K.

NW Natural appreciates the collaborative effort with EPA and its partners over the previous 2 years developing the technical evaluations and associated data gaps sampling to inform remedial design for the Gasco Sediments Site. NW Natural is eager to perform this data gaps sampling and use the validated data to complete the Sediment Remedy Basis of Design Report (BODR).

Section I: Technical Evaluations Work Plan Comment Response Review

Specific Comment

EPA Specific Comment 14

Appendix G: Section 5.4 of the BODR outline provided in Appendix G should also list "Debris" as an additional consideration.

NW Natural Response

Debris was included as an additional consideration in Section 5.4.

EPA Response

Based on review of the response this has been addressed in Section 5.2.4 and not 5.4 which EPA agrees with.

NW Natural Additional Response

Response noted.

Section II: Data Gaps Work Plan Comment Response Review

General Comment

EPA General Comment 7

Throughout the DGWP, NW Natural indicates that site-specific principal threat waste – not reliably contained (PTW-NRC) thresholds will be developed for Gasco and implies that EPA has agreed to this approach. This is a mischaracterization of the discussions between EPA and NW Natural that took place on April 4, 2019. Correct the DGWP to indicate that this discussion about PTW-NRC took place but that EPA did not specifically agree to the approach of developing PTW-NRC thresholds. Ultimately, EPA is willing to review NW Natural's proposed approach for determining site-specific PTW-NRC thresholds, and will determine upon that review if the approach is appropriate and acceptable.

NW Natural Response

Multiple sections in the DGWP have been revised to state that, consistent with the discussions on April 4, 2019, NW Natural will develop for EPA's review and approval site-specific PTW-NRC thresholds, if any, in the BODR via the capping demonstration evaluation described in Section 4.1 of the TEWP. The assumptions behind the Feasibility Study-level PTW-NRC thresholds identified in ROD Tables 7 or 21 are not consistent with site-specific conditions at the Gasco Sediments Site, and NW Natural believes the capping demonstration will generate more relevant design criteria.

EPA Response

EPA generally does not support site-specific PTW-NRC thresholds to be developed at each project area but as stated in the comment, but due to NW Natural's position concerning site-specific conditions at the Gasco Sediments Site EPA is willing to review NW Natural's proposed approach for determining site-specific PTW-NRC thresholds, and will determine upon that review if the approach is appropriate and acceptable. NW Natural and Siltronic should recognize that EPA may consider this type of proposed modification to ROD Tables 7 or 21 to require an Explanation of Significant Differences.

NW Natural Additional Response

Response noted.

Specific Comments

EPA Specific Comment 19

Section 3.2.1.2.2 Paired Bulk Subsurface Sediment and Co-Located Porewater Samples to Develop Site-Specific Equilibrium Partitioning Coefficients for VOCs, Page 19. EPA comments on this section are as follows:

1. The text states that: "if there is visual heterogeneity in sediment characteristics, the sample will be collected from the most visually impacted sediment within the sample interval." Discuss what is meant by "most visually impacted", for example, does this refer to potential visual evidence of product or NAPL impacts.

NW Natural Response

The text has been revised to discuss what is meant by "most visually impacted."

EPA Response

The revised text indicates that impacts are limited to mobile NAPL. EPA expects non-mobile product to also be considered under "most visually impacted" in the context of sampling described in Section 3.2.1.2.2.

NW Natural Additional Response

The text in Section 3.2.1.2.2 of the DGWP was revised to state, "The 'most visually impacted' sediment in the context of sampling is defined as sediments containing what appears to be the most mobile NAPL or tar based on field observations, if such sediment is apparent within the sample interval."

EPA Specific Comment 30

Section 3.3.1 Riverbank Remedy Evaluation Data Gaps Sampling Objectives and Sampling Design, Pages 27-28. EPA comments on this section are as follows:

c. Provide the rationale for limiting the bottom depth of borings to be as deep as downgradient sediment sampling locations and the range of distance between proposed riverbank borings and downgradient sediment samples. Include a protocol for the condition where the bottom of the deepest sample is contaminated.

NW Natural Response

NW Natural has committed to reconfiguring the entire riverbank adjacent to the Gasco property. Because of this, NW Natural is only proposing to characterize the "wedge" of riverbank material between the uplands and the toe of slope along the Gasco and Siltronic (if required by EPA as discussed in the response to EPA Specific Comment 30d) riverbanks. If the bottom of the deepest sample is contaminated, no additional sampling will be completed because the directly adjacent subsurface sediment core data will be used to inform the design. No revisions were made to the DGWP based on this comment.

EPA Response

The distance from bottom of riverbank borings to the nearest downgradient sediment samples should be provided in the BODR.

NW Natural Additional Response

The requested information will be provided in the BODR.

d. The text states that: "NW Natural understands the heavily armored Siltronic riverbank was constructed as a trapezoid of armor rock". Provide a reference to a document or correspondence that supports this statement. If available, include additional information and as-built cross-sections showing construction representative of the Siltronic riverbank in the DGWP or the TEWP for documentation and completeness.

NW Natural Response

NW Natural requested that Siltronic provide a reference to a document or correspondence supporting this understanding. Siltronic responded via email on August 7, 2019, and stated the following:

- Based on review of aerial photos, an undocumented class and thickness of riprap is present on the Siltronic riverbank as early as 1975 and remains in place through a 1996 flood as demonstrated in photos from 1994 and 1997 (i.e., pre- and post-flood).
- A repair of the riverbank in 1998 placed an additional 4 foot thick layer of class 1,000 and class 500 riprap along the entire Siltronic riverbank.
- Based on these findings, Siltronic believes the riprap present at the Siltronic riverbank is at least 4 feet thick, and in many areas is underlain by additional riprap placed during the initial bank construction.

Based on Siltronic's subsequent August 21, 2019 email to EPA, NW Natural understands that Siltronic is coordinating directly with EPA regarding the feasibility of collecting angled sonic borings along the top of the Siltronic riverbank. Due to the data gaps scheduled start date occurring as soon as possible in September 2019, the DGWP has been revised to include conditional collection of 4 angled riverbank borings. If EPA directs NW Natural to collect these borings, they will be collected using consistent sampling methods and chemical analyses described in the revised Section 3.3 of the DGWP. From two of the locations, waste disposal suitability characterization would be performed as described in revised Sections 3.5.1.3 and 3.5.2.3 of the DGWP. The boring locations are depicted on Figure 9 of the Work Plan.

EPA Response

EPA supports collection of the riverbank borings proposed by NW Natural at the Siltronic riverbank. The conceptual site model for the Siltronic riverbank has changed based on the information that this riverbank is not a trapezoid of armor rock, but a soil riverbank covered with armor stone. There is insufficient data available for the Siltronic riverbank and consistent with the *Guidance for River Bank Characterizations and Evaluations*, EPA expects the riverbank to be appropriately characterized.

NW Natural Additional Response

NW Natural will perform the top of riverbank borings on the Siltronic property consistent with Section 3.3 of the DGWP.

EPA Specific Comment 33

Section 3.5.1.1 Dredge Material Handling and Transport Evaluation, Page 32. NW Natural characterizes elutriate generation activities as being "short term and intermittent," and indicates that construction will only occur during a portion of the day. NW Natural uses this information to propose acute water quality criteria for discharging elutriate to the Willamette River. Although, daily discharges are projected to be low, actual volumes are currently unknown and volumes for a construction season may be large. Based on available information, discharging elutriate water to the river at concentrations greater than acute water quality criteria is not a preferred option. Consequently, NW Natural should evaluate additional alternatives, including segregating elutriate water for transfer to the uplands for treatment through the Gasco Site water treatment plant. Note that discharges to the river may involve further review by the Oregon DEQ Water Quality Program of elutriate constituents, testing methods, and discharge criteria and may require comparison with chronic water quality criteria. Additionally, the text states that: "Consistent with EPA's Specific Comment 2 in Appendix D, NW Natural will analyze the dredge dewatering elutriate samples for the ROD Table 17 chemicals with groundwater cleanup levels." Revise this list to include all Table 17

COCs with surface water cleanup levels, especially to include dioxin/furan analyses. An appropriate water quality criterion for the dioxin/furans can be discussed with EPA and DEQ.

NW Natural Response

NW Natural agrees that any dredge material haul barge elutriate discharges into the Willamette River during construction should be evaluated using applicable promulgated freshwater acute criteria. These criteria should be applied at the edge of a construction mixing zone, the dimensions of which would be determined in consultation with EPA during remedial design. If the pre-remedial design sampling data identify that the elutriate may exceed the applicable criteria during construction, NW Natural will evaluate water treatment prior to discharge to the Willamette River or an alternate means of water management and disposal. NW Natural understands that the Oregon Department of Environmental Quality (DEQ) Water Quality Program may provide input to the water quality monitoring program.

Revisions have been made to the referenced section of the DGWP to analyze the dredge dewatering elutriate samples for those chemicals containing ROD Table 17 surface water cleanup levels that have applicable acute water quality criteria or reliable acute ecological screening values for surface water. The previous DGWP text inadvertently identified analysis of chemicals with ROD Table 17 groundwater CULs, which is not applicable to surface water discharges. Although dioxins/furans have a surface water CUL, there are no state or federal aquatic life (acute and chronic) water quality criteria for dioxins; therefore, construction monitoring for dioxins should not be required. Aquatic life criteria are not readily available because dioxin toxicity occurs primarily through bioaccumulation, which is not representative of short-term construction activities. No revisions were made to the DGWP based on this comment.

EPA Response

The response indicates that dredge elutriate discharges will be evaluated against the "promulgated freshwater acute criteria". Acute criteria for certain constituents, such as PAHs, are not included in DEQ's promulgated water quality standards (OAR 340-041 Table 30). The appropriate criteria for these constituents may not be limited to those strictly promulgated in state or federal law (for example, the EPA Tier 2 water quality standards) and therefore should be developed through consultation with EPA and DEQ. Comparison to chronic water quality standards may also be required as indicated in the comment.

NW Natural Additional Response

NW Natural will consult further with EPA during development of the BODR to determine the appropriate criteria for treated dredge elutriate discharges into the Willamette River within the construction work area.

EPA Specific Comment 45

Figure 13. This figure identifies locations for analysis of "non site-specific" COCs, however many of these COCs are located and exceed RALs within the project area (e.g., PCBs, DDx). Provide clarification for the term "non-site specific" and retitle the figure as needed.

NW Natural Response

Historical and current operations at the Gasco property did not include sources of PCBs, DDx, or dioxin/furans so they are categorized as non-site specific COCs. No changes have been made to the DGWP, and this categorization will not affect remedial design decisions (although the extent and concentration of these and other COCs may).

EPA Response

For the record, include a clarifying footnote that the non-site specific categorization is based on historical and current site operations.

NW Natural Additional Response

The DGWP and associated appendices have been revised consistent with this comment.

EPA Specific Comment 49

Appendix A – Field Sampling Plan, 3.2.2.1 Interim Project Area Refinement and Additional Surface Sediment Data Density, Page 5. The text states that: "If no material is recovered after two attempts at a subsample location, the location will be offset to a maximum of a 50-foot radius from the target location." EPA requests that three attempts be made at each subsample location before moving to a 50-foot radius and three attempts should be made at the 50-foot radius alternate location as well.

NW Natural Response

The FSP has been revised to state that no more than six individual subsample attempts will occur at each composite location, and the three attempts with the highest recovery will be retained. If the composite average is greater than 0.3 feet, the sample will be retained for analysis. This approach is consistent with the recent EPA-approved surface sediment sampling performed by the Port of Portland at the Terminal 4 site.

EPA Response

EPA has reviewed the Terminal 4 SQAPP with this information which provides required context. For clarity, revise this sentence in Section 3.2.2.1 to read as follows: "If the composite average ***recovery*** is greater than 0.3 feet, the sample will be retained for analysis."

NW Natural Additional Response

The request revision has been made to the referenced section in the FSP.

EPA Specific Comment 78

Appendix A – Field Sampling Plan, Section 5.3.7 Extracted Subsurface NAPL Samples, Page 47. Include wettability in the list of NAPL properties being evaluated. The text states that the TPH measurements from the NAPL extracted from subsurface sediment cores will be used to estimate the amount of TPH in sheen samples. Describe the methodology for applying these results to the sheen samples.

NW Natural Response

Wettability has been added to the list of NAPL properties being evaluated. TPH analysis of NAPL will indicate the percentage of the NAPL mass detectible in a TPH scan. Using this information, sheen TPH data, and the mass of a given sheen net, the total NAPL mass in a given sheen sample can be calculated. For example, if the TPH value for the NAPL is 900,000 milligrams per kilogram, detectible TPH comprises 90% of the NAPL mass. Then the TPH mass collected using sheen nets will be multiplied by (1/0.9) to estimate the total NAPL mass within a given sheen sample.

EPA Response

EPA understands a follow-up discussion between EPA's contractor (CDM Smith) and Anchor QEA resulted in Anchor QEA providing information from two EPA-managed cleanup sites where the measurement of TPH was performed as the primary metric to evaluate mass flux. This information should be referenced and summarized in the BODR when presenting the information obtained at the Gasco Sediments Site. NW Natural will be expected to provide supporting information to document that NAPL mass can be estimated using TPH measurements.

NW Natural Additional Response

This information will be referenced and summarized in the BODR and provide supporting information to document that NAPL mass can be estimated using TPH measurements.

Additional Comments to the DGWP

EPA Additional Comment 1

Text was added to Sections 3.1.1 and 3.1.1.2 of the DGWP stating that subsurface concentrations will be evaluated to determine if any subsurface exceedances "have the potential for future exposure as surface sediments based on chemical and physical characteristics". The revised text ignores the potential for contaminated porewater to advect to the sediment surface. EPA recommends revising this text as follows: "…have the potential for future exposure based on chemical and physical characteristics". NW Natural should consult Section 1.4 of EPA's Remedial Design Guidelines and Considerations for more information.

NW Natural Response

The request revisions have been made to the referenced sections in the DGWP.

EPA Additional Comment 2

Section 3.2.2.1.2 incorrectly references figures in Appendix E. Revise to reference relevant figures in Appendix F.

NW Natural Response

The request revision has been made to the referenced section in the DGWP.

EPA Additional Comment 3

EPA requests that information provided in the responses to the following comments be incorporated in the relevant sections of the text or table footnotes of the DGWP and its appendices: 19c, 20b, 26, 28a, 30d, 35, 38, 61, 63, 87, and 99.

NW Natural Response

The request revisions have been made to the appropriate sections in the DGWP and associated appendices.

EPA Additional Comment 4

The information provided in Attachments B to D of Appendix K (Memorandum Regarding: "NW Natural Response to EPA Comments on Work Plan") should be included in the BODR.

NW Natural Response

The information in the referenced appendices will be included in the BODR.

Attachment A
Conditional Approval for Final Pre-Remedial Basis of Design Technical Evaluations Work Plan and Revised Pre-Remedial Design Data Gaps Work Plan, Gasco Sediments Cleanup Action

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 10
1200 Sixth Avenue, Suite 155
Seattle, WA 98101-3123

SUPERFUND &
EMERGENCY
MANAGEMENT DIVISION

September 6, 2019

Mr. Bob Wyatt
NW Natural
220 NW 2nd Avenue
Portland OR 97209

sent via email only

Mr. Myron Burr
Siltronic Corporation
7200 NW Front Avenue, M/S 20
Portland, Oregon 97210-3676

Re: Conditional Approval for Final Pre-Remedial Basis of Design Technical Evaluations Work Plan and Revised Pre-Remedial Design Data Gaps Work Plan, Gasco Sediments Cleanup Action

Dear Sirs:

The U.S. Environmental Protection Agency (EPA) has reviewed the Final Pre-Remedial Basis of Design Technical Evaluations Work Plan (TEWP) dated August 29, 2019, the Revised Pre-Remedial Design Data Gaps Work Plan (DGWP) dated August 22, 2019, and the Summary of Final Cap Modeling and Long-Term Cap Monitoring Approach – Gasco Sediments Site (Capping Approach) dated June 25, 2019 and presented as TEWP Appendix H. The EPA conditionally approves the TEWP, DGWP, and Capping Approach; the attachment provides those items that are conditioned on this approval. Please revise the documents as noted in the attachment and deliver to EPA prior to initiating the DGWP scope. EPA appreciates the collaborative effort over the previous two years developing the technical evaluations and associated data gaps sampling to inform remedial design for the Gasco Sediments Site. While EPA believes the scope detailed in the DGWP will likely provide the dataset necessary for remedial design, if after review of the Sediment Remedy Basis of Design Report EPA determines additional data needs are required to finish the technical evaluations identified in the EPA-approved TEWP so that remedial design can be completed, then EPA expects that NW Natural and Siltronic will address those data needs in a supplemental data gaps investigation.

Please let me know if you have any questions or concerns at (206) 553-1220 or via email at sheldrake.sean@epa.gov.

Sincerely,

Sean Sheldrake, RPM

Cc:
Lance Peterson, CDM/S via email only
Dana Bayuk, ODEQ

Attachment

I. Technical Evaluations Work Plan Comment Response Review

EPA reviewed NW Natural's responses to EPA's August 23, 2019 comments on the final revised Pre-Remedial Design Technical Evaluations (TEWP) dated August 29, 2019. NW Natural's response to the EPA comments are acceptable to EPA. A clarification to one TEWP comment is provided below.

EPA Specific Comment 14

Appendix G: Section 5.4 of the BODR outline provided in Appendix G should also list "Debris" as an additional consideration.

NW Natural Response

Debris was included as an additional consideration in Section 5.4.

EPA Response

Based on review of the response this has been addressed in Section 5.2.4 and not 5.4 which EPA agrees with.

II. Data Gaps Work Plan Comment Response Review

EPA reviewed NW Natural's responses to EPA's August 12, 2019 comments on the Revised Pre-Remedial Design Data Gaps Work Plan (DGWP) dated August 22, 2019. NW Natural's response to the following EPA comments are acceptable to EPA:

- General Comments 1-6, and 8-15
- Specific Comments 1-18, 20-29, 31, 32, 34-44, 46-48, 50-77, and 79-118
- All editorial comments

Approval of the DGWP is conditioned on acceptance of EPA's responses to the following comments.

EPA General Comment 7

Throughout the DGWP, NW Natural indicates that site-specific principal threat waste – not reliably contained (PTW-NRC) thresholds will be developed for Gasco and implies that EPA has agreed to this approach. This is a mischaracterization of the discussions between EPA and NW Natural that took place on April 4, 2019. Correct the DGWP to indicate that this discussion about PTW-NRC took place but that EPA did not specifically agree to the approach of developing PTW-NRC thresholds. Ultimately, EPA is willing to review NW Natural's proposed approach for determining site-specific PTW-NRC thresholds, and will determine upon that review if the approach is appropriate and acceptable.

NW Natural Response

Multiple sections in the DGWP have been revised to state that, consistent with the discussions on April 4, 2019, NW Natural will develop for EPA's review and approval site-specific PTW-NRC thresholds, if any, in the BODR via the capping demonstration evaluation described in Section 4.1 of the TEWP. The assumptions behind the Feasibility

Study-level PTW-NRC thresholds identified in ROD Tables 7 or 21 are not consistent with site-specific conditions at the Gasco Sediments Site, and NW Natural believes the capping demonstration will generate more relevant design criteria.

EPA Response

EPA generally does not support site-specific PTW-NRC thresholds to be developed at each project area but as stated in the comment, but due to NW Natural's position concerning site-specific conditions at the Gasco Sediments Site EPA is willing to review NW Natural's proposed approach for determining site-specific PTW-NRC thresholds, and will determine upon that review if the approach is appropriate and acceptable. NW Natural and Siltronic should recognize that EPA may consider this type of proposed modification to ROD Tables 7 or 21 to require an Explanation of Significant Differences.

EPA Specific Comment 19

Section 3.2.1.2.2 Paired Bulk Subsurface Sediment and Co-Located Porewater Samples to Develop Site-Specific Equilibrium Partitioning Coefficients for VOCs, Page 19. EPA comments on this section are as follows:

1. The text states that: "if there is visual heterogeneity in sediment characteristics, the sample will be collected from the most visually impacted sediment within the sample interval." Discuss what is meant by "most visually impacted", for example, does this refer to potential visual evidence of product or NAPL impacts.

NW Natural Response

The text has been revised to discuss what is meant by "most visually impacted."

EPA Response

The revised text indicates that impacts are limited to mobile NAPL. EPA expects non-mobile product to also be considered under "most visually impacted" in the context of sampling described in Section 3.2.1.2.2.

EPA Specific Comment 30

Section 3.3.1 Riverbank Remedy Evaluation Data Gaps Sampling Objectives and Sampling Design, Pages 27-28. EPA comments on this section are as follows:

c. Provide the rationale for limiting the bottom depth of borings to be as deep as downgradient sediment sampling locations and the range of distance between proposed riverbank borings and downgradient sediment samples. Include a protocol for the condition where the bottom of the deepest sample is contaminated.

NW Natural Response

NW Natural has committed to reconfiguring the entire riverbank adjacent to the Gasco property. Because of this, NW Natural is only proposing to characterize the "wedge" of riverbank material between the uplands and the toe of slope along the Gasco and Siltronic (if required by EPA as discussed in the response to EPA Specific Comment 30d) riverbanks. If the bottom of the deepest sample is contaminated, no additional sampling will be completed because the directly adjacent subsurface sediment core data will be used to inform the design. No revisions were made to the DGWP based on this comment.

EPA Response

The distance from bottom of riverbank borings to the nearest downgradient sediment samples should be provided in the BODR.

d. The text states that: "NW Natural understands the heavily armored Siltronic riverbank was constructed as a trapezoid of armor rock". Provide a reference to a document or correspondence that supports this statement. If available, include additional information and as-built cross-sections showing construction representative of the Siltronic riverbank in the DGWP or the TEWP for documentation and completeness.

NW Natural Response

NW Natural requested that Siltronic provide a reference to a document or correspondence supporting this understanding. Siltronic responded via email on August 7, 2019, and stated the following:

- Based on review of aerial photos, an undocumented class and thickness of riprap is present on the Siltronic riverbank as early as 1975 and remains in place through a 1996 flood as demonstrated in photos from 1994 and 1997 (i.e., pre- and post-flood).
- A repair of the riverbank in 1998 placed an additional 4 foot thick layer of class 1,000 and class 500 riprap along the entire Siltronic riverbank.
- Based on these findings, Siltronic believes the riprap present at the Siltronic riverbank is at least 4 feet thick, and in many areas is underlain by additional riprap placed during the initial bank construction.

Based on Siltronic's subsequent August 21, 2019 email to EPA, NW Natural understands that Siltronic is coordinating directly with EPA regarding the feasibility of collecting angled sonic borings along the top of the Siltronic riverbank. Due to the data gaps scheduled start date occurring as soon as possible in September 2019, the DGWP has been revised to include conditional collection of 4 angled riverbank borings. If EPA directs NW Natural to collect these borings, they will be collected using consistent sampling methods and chemical analyses described in the revised Section 3.3 of the DGWP. From two of the locations, waste disposal suitability characterization would be performed as described in revised Sections 3.5.1.3 and 3.5.2.3 of the DGWP. The boring locations are depicted on Figure 9 of the Work Plan.

EPA Response

EPA supports collection of the riverbank borings proposed by NW Natural at the Siltronic riverbank. The conceptual site model for the Siltronic riverbank has changed based on the information that this riverbank is not a trapezoid of armor rock, but a soil riverbank covered with armor stone. There is insufficient data available for the Siltronic riverbank and consistent with the *Guidance for River Bank Characterizations and Evaluations*, EPA expects the riverbank to be appropriately characterized.

EPA Specific Comment 33

Section 3.5.1.1 Dredge Material Handling and Transport Evaluation, Page 32. NW Natural characterizes elutriate generation activities as being "short term and intermittent," and indicates that construction will only occur during a portion of the day. NW Natural uses this information to propose acute water quality criteria for discharging elutriate to the Willamette River. Although, daily discharges are projected to be low, actual volumes are currently unknown and volumes for a construction season may be large. Based on available information, discharging elutriate water to the river at concentrations greater than acute water quality criteria is not a preferred option. Consequently, NW Natural should evaluate additional alternatives, including segregating elutriate water for transfer to the uplands for treatment through the Gasco Site water treatment plant. Note that discharges to the river may involve further review by the Oregon DEQ Water Quality Program of elutriate constituents, testing methods, and discharge criteria and may require comparison with chronic water quality criteria. Additionally, the text states that: "Consistent with EPA's Specific Comment 2 in Appendix D, NW Natural will analyze the dredge dewatering elutriate samples for the ROD Table 17 chemicals with groundwater cleanup levels." Revise this list to include all Table 17 COCs with surface water cleanup levels, especially to include dioxin/furan analyses. An appropriate water quality criterion for the dioxin/furans can be discussed with EPA and DEQ.

NW Natural Response

NW Natural agrees that any dredge material haul barge elutriate discharges into the Willamette River during construction should be evaluated using applicable promulgated freshwater acute criteria. These criteria should be applied at the edge of a construction mixing zone, the dimensions of which would be determined in consultation with EPA during remedial design. If the pre-remedial design sampling data identify that the elutriate may exceed the applicable criteria during construction, NW Natural will evaluate water treatment prior to discharge to the Willamette River or an alternate means of water management and disposal. NW Natural understands that the Oregon Department of Environmental Quality (DEQ) Water Quality Program may provide input to the water quality monitoring program.

Revisions have been made to the referenced section of the DGWP to analyze the dredge dewatering elutriate samples for those chemicals containing ROD Table 17 surface water cleanup levels that have applicable acute water quality criteria or reliable acute ecological screening values for surface water. The previous DGWP text inadvertently identified analysis of chemicals with ROD Table 17 groundwater CULs, which is not applicable to surface water discharges. Although dioxins/furans have a surface water CUL, there are no state or federal aquatic life (acute and chronic) water quality criteria for dioxins; therefore, construction monitoring for dioxins should not be required. Aquatic life criteria are not readily available because dioxin toxicity occurs primarily through bioaccumulation, which is not representative of short-term construction activities. No revisions were made to the DGWP based on this comment.

EPA Response

The response indicates that dredge elutriate discharges will be evaluated against the "promulgated freshwater acute criteria". Acute criteria for certain constituents, such as PAHs, are not included in DEQ's promulgated water quality standards (OAR 340-041 Table 30). The appropriate criteria for these constituents may not be limited to those strictly promulgated in state or federal law (for example, the EPA Tier 2 water quality standards) and therefore should be developed through consultation with EPA and DEQ. Comparison to chronic water quality standards may also be required as indicated in the comment.

EPA Specific Comment 45

Figure 13. This figure identifies locations for analysis of "non site-specific" COCs, however many of these COCs are located and exceed RALs within the project area (e.g., PCBs, DDx). Provide clarification for the term "non-site specific" and retitle the figure as needed.

NW Natural Response

Historical and current operations at the Gasco property did not include sources of PCBs, DDx, or dioxin/furans so they are categorized as non-site specific COCs. No changes have been made to the DGWP, and this categorization will not affect remedial design decisions (although the extent and concentration of these and other COCs may).

EPA Response

For the record, include a clarifying footnote that the non-site specific categorization is based on historical and current site operations.

EPA Specific Comment 49

Appendix A – Field Sampling Plan, 3.2.2.1 Interim Project Area Refinement and Additional Surface Sediment Data Density, Page 5. The text states that: "If no material is recovered after two attempts at a subsample location, the location will be offset to a maximum of a 50-foot radius from the target location." EPA requests that three attempts be made at each subsample location before moving to a 50-foot radius and three attempts should be made at the 50-foot radius alternate location as well.

NW Natural Response

The FSP has been revised to state that no more than six individual subsample attempts will occur at each composite location, and the three attempts with the highest recovery will be retained. If the composite average is greater than 0.3 feet, the sample will be retained for analysis. This approach is consistent with the recent EPA-approved surface sediment sampling performed by the Port of Portland at the Terminal 4 site.

EPA Response

EPA has reviewed the Terminal 4 SQAPP with this information which provides required context. For clarity, revise this sentence in Section 3.2.2.1 to read as follows: "If the composite average ***recovery*** is greater than 0.3 feet, the sample will be retained for analysis."

EPA Specific Comment 78

Appendix A – Field Sampling Plan, Section 5.3.7 Extracted Subsurface NAPL Samples, Page 47. Include wettability in the list of NAPL properties being evaluated. The text states that the TPH measurements from the NAPL extracted from subsurface sediment cores will be used to estimate the amount of TPH in sheen samples. Describe the methodology for applying these results to the sheen samples.

NW Natural Response

Wettability has been added to the list of NAPL properties being evaluated. TPH analysis of NAPL will indicate the percentage of the NAPL mass detectible in a TPH scan. Using this information, sheen TPH data, and the mass of a given sheen net, the total NAPL mass in a given sheen sample can be calculated. For example, if the TPH value for the NAPL is 900,000 milligrams per kilogram, detectible TPH comprises 90% of the NAPL mass. Then the TPH mass collected using sheen nets will be multiplied by (1/0.9) to estimate the total NAPL mass within a given sheen sample.

EPA Response

EPA understands a follow-up discussion between EPA's contractor (CDM Smith) and Anchor QEA resulted in Anchor QEA providing information from two EPA-managed cleanup sites where the measurement of TPH was performed as the primary metric to evaluate mass flux. This information should be referenced and summarized in the BODR when presenting the information obtained at the Gasco Sediments Site. NW Natural will be expected to provide supporting information to document that NAPL mass can be estimated using TPH measurements.

Additional Comments to the DGWP

1. Text was added to Sections 3.1.1 and 3.1.1.2 of the DGWP stating that subsurface concentrations will be evaluated to determine if any subsurface exceedances “have the potential for future exposure as surface sediments based on chemical and physical characteristics”. The revised text ignores the potential for contaminated porewater to advect to the sediment surface. EPA recommends revising this text as follows: “…have the potential for future exposure based on chemical and physical characteristics”. NW Natural should consult Section 1.4 of EPA’s Remedial Design Guidelines and Considerations for more information.
2. Section 3.2.2.1.2 incorrectly references figures in Appendix E. Revise to reference relevant figures in Appendix F.
3. EPA requests that information provided in the responses to the following comments be incorporated in the relevant sections of the text or table footnotes of the DGWP and its appendices: 19c, 20b, 26, 28a, 30d, 35, 38, 61, 63, 87, and 99.
4. The information provided in Attachments B to D of Appendix K (Memorandum Regarding: “NW Natural Response to EPA Comments on Work Plan”) should be included in the BODR.